Jeanine Kirchner-Krath

# Gamification for Sustainable Employee Behavior

## A Design Science Research Study

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Dissertation

# Gamification for Sustainable Employee Behavior

## A Design Science Research Study

by

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# Preface

The time has come: after intense work, extensive research and lots of new insights, the results of my dissertation have been bundled into a single book. And it almost seems like a summary of a chapter of my life: three years in one book. Three years in which I have learned so much, experienced so much, and met so many great, inspiring new people as I could never have imagined on the first day. And that is exactly why this work, although it has my name on the cover, is not the work of one individual. Many people who have accompanied, supported, and continuously encouraged me to rise above myself over the past few years deserve great thanks for making this piece of work possible.

First and foremost, I would like to thank my supervisors *Harald von Korflesch* and *Benedikt Morschheuser* for their comprehensive support and advice.

I would like to thank *Harald von Korflesch*, my "docfather", for his everlasting support throughout the years. Harald, you already believed in me and my scientific career when I didn't believe in it myself - and when I finally made the decision to start a PhD, you welcomed me with open arms. Thank you for accompanying me on my entire academic journey so far and for hopefully continuing to do so in the future.

Additionally, I would like to thank *Benedikt Morschheuser* for his professional guidance. Benedikt, I never thought that one message could ever lead to such a deep collaboration, and that it could win me not only a supervisor for my dissertation, but also a mentor who wants to shape research in our field together with me. I have learned indescribably much from you and had great fun in all our collaborations, and I look forward to the future.

Of course, I would also like to thank the *Stiftung der Deutschen Wirtschaft (sdw)* for supporting this dissertation with a scholarship that allowed me to fully concentrate on my research and work towards my scientific career.

Furthermore, I would like to thank *Juho Hamari* for welcoming me so warmly to his research group for three months. Juho, my time in Tampere has broadened my perspective on the gamification field and my knowledge of research to a degree I could not have imagined. Thank you for allowing me to meet so many great scientists and so many exciting projects through your hospitality. I hope that we will continue and expand our collaboration in the future.

In addition, I would like to thank my very first co-author, *Samanthi Dijkstra-Silva*. Samanthi, I don't know where I would be today if you hadn't offered to support me so intensively on my first paper. Thank you for opening the way to my first publications and thus starting my scientific career with me. I look forward to continuing to work with you in the future.

Moreover, I would like to thank all of my co-authors, whose experience, knowledge, and dedication helped me to publish and present my work - both as part of the dissertation and beyond - at international journals and conferences, and thereby meet so many more great people. I have learned so much from all of you.

Finally, and most importantly, I would like to thank my family and friends.

Above all, I would like to thank my beloved husband *Johannes*, who more than anyone else has always and unconditionally supported me. Johannes, I don't know if I could have done this dissertation without you at all. You were always the first to know about a new idea, and the last to read over each paper (and I know they are not easy evening read most of the time) before I submitted it. You rejoiced with me over every success and complained with me about stupid reviews, you had my back during stressful times and supported me in every possible way. Thank you for always believing in me and being by my side.

I would like to thank the best mom and dad in the world, *Renate and Uli*. Mom, Dad, you have always supported me throughout my life and the fact that I have been allowed to receive and pursue so many

chances in my life that have led me to this point is all thanks to you. Whether you were practicing application talks with me at the dinner table, bravely being the first users of the app, helping to acquire participants in spontaneous emergencies, or just patiently listening to what was on my mind during this PhD, I wouldn't have gotten this far without you. Thank you for always believing in me and being by my side.

I would like to thank my dearest parents-in-law, *Margit and Klaus*, and of course my favorite brother-in-law, *Valentin*. You made sure every single Sunday that I could start the upcoming week with energy, cheered me along before every deadline, and encouraged me tirelessly that I can overcome any challenge. Thank you for always believing in me and being by my side.

Lastly, I would like to thank all of my friends, who I am sure have spent many days and evenings over the past three years learning more details about this dissertation than they wanted to, and yet never tired of talking with me about it. You have all contributed - each in your own way - to the fact that this book is here in front of me today. Thank you for always believing in me and being by my side.

*Jeanine Kirchner-Krath*

# Abstract in English

With the increasing importance and urgency of climate change, companies are challenged to contribute to sustainable development, especially by younger generations. However, existing corporate contributions have been criticized as insufficient, which could be particularly caused by a lack of employee engagement in corporate sustainability. In this context, *gamification* has been proposed and increasingly investigated in recent years as a promising, innovative tool to motivate sustainable employee behaviors in the workplace. However, there are few studies and applicable gamification solutions that address more than one specific sustainability issue and thus take a holistic perspective on sustainable behaviors in the workplace. Moreover, previous research lacks a comprehensive understanding of how different gamification elements elicit specific psychological effects, how these manifest in behavioral changes, and how these, in turn, cumulatively result in measurable corporate outcomes. The path from gamification as ”input” to corporate sustainability as ”output” thus remains unexplored.

This dissertation fills this gap by conceptualizing, designing, and evaluating a holistic gamified intervention that supports employees in various sustainable behaviors in their daily activities. The project uses a design science research approach that closely involves employees in the incremental development of the solution. As part of the iterative design process, this dissertation presents six studies to extend the theoretical understanding of gamification for sustainable employee behaviors. First, a comprehensive review of existing research on gamification for sustainable employee behavior is provided, analyzing gamification designs and results of previous studies and outlining an agenda for further research (Study 1). Theoretical foundations of research on gamification, serious games, and game-based learning (Study 2) and empirical design principles for gamification and persuasive systems (Study 3) are then systematically reviewed as a basis for the successful design of gamified applications. Subsequently, empirical studies explore employees' motivations for sustainable behavior and illuminate their expectations for design features (Study 4), and identify contextual challenges and design dilemmas when implementing gamification in an organizational context (Study 5). Finally, a quantitative field study (Study 6) explores how different gamification designs influence sustainable employee behavior and corporate sustainability in organizations. Based on the findings, this dissertation presents a comprehensive framework of gamification for sustainable employee behavior that incorporates design, individual behavior, and organizational perspectives. Finally, building on these insights, it provides practical recommendations for designing gamification to encourage sustainable employee behavior at work.

# Abstract in German

Durch die zunehmende Wichtigkeit und Dringlichkeit des Klimawandels sind Unternehmen aufgefordert, einen Beitrag zu nachhaltiger Entwicklung zu leisten, insbesondere durch die jüngeren Generationen. Bisherige Beiträge von Unternehmen werden jedoch als unzureichend kritisiert, was insbesondere am mangelnden Engagement der Mitarbeiterinnen und Mitarbeiter für Nachhaltigkeit in Unternehmen liegen könnte. In diesem Zusammenhang wurde in den letzten Jahren *Gamification* als ein vielversprechendes, innovatives Tool um nachhaltige Verhaltensweisen der Mitarbeiterinnen und Mitarbeiter am Arbeitsplatz zu motivieren, vorgeschlagen und zunehmend erforscht. Es gibt jedoch nur wenige Studien und anwendbare Gamification-Lösungen, die mehr als ein spezifisches Nachhaltigkeitsthema behandeln und somit eine ganzheitliche Perspektive auf nachhaltige Verhaltensweisen am Arbeitsplatz einnehmen. Darüber hinaus mangelt es bisheriger Forschung an einem umfassenden Verständnis dafür, wie verschiedene Gamification-Elemente spezifische psychologische Effekte hervorrufen, wie sich diese in Verhaltensänderungen manifestieren und wie diese wiederrum kumulativ in messbaren Unternehmensergebnissen resultieren. Der Weg von Gamification als "Input" zu unternehmerischer Nachhaltigkeit als "Output" ist also bislang unerforscht.

Diese Dissertation schließt diese Lücke, indem eine ganzheitliche gamifizierte Intervention konzipiert, gestaltet und evaluiert wird, die Mitarbeiterinnen und Mitarbeiter bei verschiedenen nachhaltigen Verhaltensweisen in ihren täglichen Aktivitäten unterstützt. Das Projekt verwendet einen designwissenschaftlichen Forschungsansatz, der die Mitarbeiterinnen und Mitarbeiter eng in die schrittweise Entwicklung der Lösung einbezieht. Als Teil des iterativen Designprozesses werden in dieser Dissertation sechs Studien vorgestellt, um das theoretische Verständnis von Gamification für nachhaltige Verhaltensweisen von Mitarbeiterinnen und Mitarbeitern zu erweitern. Zunächst wird ein umfassender Überblick über die bestehende Forschung zu Gamification für nachhaltiges Mitarbeiterverhalten gegeben, wobei Gamification-Designs und Ergebnisse früherer Studien analysiert und eine Agenda für die weitere Forschung aufgezeigt werden (Studie 1). Danach werden theoretische Grundlagen der Forschung zu Gamification, Serious Games und Game-based Learning (Studie 2) und empirische Gestaltungsprinzipien für Gamification und persuasive Systeme (Studie 3) als Basis für die erfolgreiche Gestaltung gamifizierter Anwendungen systematisch untersucht. Anschließend werden in empirischen Studien Motivationen der Mitarbeiterinnen und Mitarbeiter für nachhaltiges Verhalten erforscht und ihre Erwartungen an Gestaltungsmerkmale beleuchtet (Studie 4) sowie kontextuelle Herausforderungen und Gestaltungsdilemmata bei der Implementierung von Gamification in einem organisatorischen Kontext aufgezeigt (Studie 5). Schließlich wird in einer quantitativen Feldstudie (Studie 6) untersucht, wie verschiedene Gamification-Designs nachhaltiges Mitarbeiterverhalten und unternehmerische Nachhaltigkeitskennzahlen in Organisationen beeinflussen. Basierend auf den Ergebnissen wird in dieser Dissertation ein umfassendes Framework für Gamification für nachhaltiges Mitarbeiterverhalten präsentiert, welches Design-, individuelle Verhaltens- und Unternehmensperspektiven einbezieht. Schließlich werden darauf aufbauend praktische Empfehlungen für die Gestaltung von Gamification zur Förderung nachhaltigen Mitarbeiterverhaltens am Arbeitsplatz präsentiert.

# How to Read this Thesis

Hello and welcome, dear reader!

I am Leafy, and just as I am part of the Greenify.work application developed during this research project, I am also part of this thesis. I will be happy to assist and guide you through the following document. To begin, I would like to explain the various elements that you will encounter in this document, which should help structure the text and your thoughts.

First, please note that references [1] are inserted in numbered form so as to disrupt the flow of reading as little as possible. The corresponding author-date notation is displayed in the margin to provide more information about the reference without you having to leap to the bibliography.

[1]: Krath *et al.* (2021)

Second, research questions, hypotheses, or important statements are highlighted in a yellow box to help you easily identify and retrace them.

**Research question:** *This is an exemplary research question.*

Third, whenever there is a remark that complements the main text, you will spot me above a greenish box in the margin where I provide the relevant information.

**Important note.**

In case there is relevant additional information that complements the text, I am here for you.

Finally, after each chapter that deals with studies conducted as part of this research project, I will help you take away the key findings by giving you a brief summary of the main learnings from that study.

After each study, I will give you an overview of the main learnings in a green box like this.

I hope that my guidance will lead to a fabulous reading experience for you! So, enough of the introductory words - enjoy reading the thesis and see you in the next chapters!

# Contents

# List of Figures

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# List of Abbreviations

C

**CCDF** Complementary Cumulative Distribution Function. 243–245

D

**DOI** Theory of Diffusion of Innovations. 26, 35, 84, 171, 173, 174, 179, 181, 199, 201, 318, 319

**DSR** Design Science Research. 4, 7–13, 31, 35, 72, 98, 99, 111, 114, 119, 125–127, 144, 145, 148, 150, 151, 154–160, 170, 171, 196, 202, 203, 206, 207, 210, 213–218, 220, 226, 258, 275

F

**FEDS** Framework for Evaluation in Design Science Research. 8, 9, 12, 126, 171, 227

H

**HRM** Human Resource Management. 23

I

**IS** Information Systems. 3, 4, 7–9, 12, 15, 18, 24–27, 32, 35, 36, 38, 63, 101, 103, 114, 127, 130, 137, 171–177, 179–183, 185–187, 189–191, 195–202, 227, 228, 230, 235, 250, 252, 255, 258, 260–263, 273

**IT** Information Technology. 24

M

**MDA** Mechanics, Dynamics and Aesthetics Framework. 31, 32, 84, 110

**MVP** Minimum Viable Product. 5, 8, 12, 145, 148, 154, 160–171, 176, 203, 206–211, 213–218, 221, 222, 224

N

**NAM** Norm Activation Model. 21, 25, 228

P

**PEB** Pro-Environmental Behavior. 20, 22, 24, 34, 232, 238

**PLS** Partial Least Squares. 235, 236

**PRISMA** Preferred Reporting Items for Systematic Reviews and Meta-Analyses. 9, 74

R

**ROSES** Reporting Standards for Systematic Evidence Syntheses. 9, 11, 41, 74, 75, 101

S

**SDG** Sustainable Development Goal. 2–4, 7, 19, 39, 41–45, 61–63, 65, 66, 116, 227, 229, 247, 248, 273, 279

**SDT** Self-Determination Theory. 11, 25, 46, 64, 73, 75, 78, 87–92, 94, 252, 259, 304

**SEM** Structural Equation Modeling. 14, 234–236, 238, 239, 244–246

T

**TAM** Technology Acceptance Model. 11, 25, 32, 65, 73, 83, 88, 90, 92, 94, 172, 259, 307

**TPB** Theory of Planned Behavior. 13, 21, 22, 25, 36, 39, 43, 46, 55, 64, 65, 67, 83, 87, 88, 90, 91, 94, 126, 227, 228, 230, 232, 238–240, 249, 252, 259, 261, 307

**TRA** Theory of Reasoned Action. 21, 46, 55, 83, 87, 90, 307

**TTM** Transtheoretical Model of Behavior Change. 11, 64, 73, 83, 88, 89, 91, 173, 308

U

**UTAUT2** Unified Theory of Acceptance and Use of Technology. 25

V

**VBN** Value-Belief-Norm Theory. 21, 22, 126, 129, 142, 228, 252, 261

**VR** Virtual Reality. 46, 52

# Introduction

# 1 Introduction



## 1.1 Motivation

Human activities are estimated to be responsible for global warming of about 1.0°C above pre-industrial levels and are likely to cause further increase to 1.5°C or even 2.0°C in the coming decades. Accordingly, climate models predict an increase in mean land and ocean temperatures, hot extremes, and a higher likelihood of droughts and extreme precipitation [2]. The past decade has been the ten warmest years since records began in 1880 [3], and severe droughts causing large bushfires, such as the 2019-2020 "mega-fire" season in Australia [4], and devastating floods in 2021 in Germany's Ahr Valley with more than 200 victims [5] are likely just harbingers of widespread global climate change and weather anomalies. In the Paris Climate Agreement, ratified by 187 countries [6], parties agreed to continue efforts to limit global warming to 1.5°C above pre-industrial levels by implementing intended national contributions - but additional national, subnational, and explicitly non-governmental action is inevitable to achieve the target [7]. Companies, in particular, are increasingly required to contribute to sustainable development, engage in corporate sustainability, and continuously improve their sustainability performance [8]–[10], especially by younger generations [11]. To this end, the United Nations developed a global sustainable development agenda in the form of 17 Sustainable Development Goals (SDGs) to guide the coordination of individual, organizational, and governmental efforts toward sustainability across multiple dimensions - environmental (e.g., climate action, responsible consumption and production, terrestrial and aquatic biodiversity, and clean energy), as well as economic (e.g., decent work, economic growth, and innovation) and social (e.g., addressing poverty and inequality and promoting health and well-being) [12].

In recent years, an increasing number of companies have recognized the need to adopt sustainability measures and implement voluntary environmental management standards [13], commit to sustainability [10], [14], and report on their sustainability performance [15], [16]. Nevertheless, current corporate efforts have been criticized as insufficient [14], [17]. One of the main reasons for these difficulties could be the lack of employee engagement. Employee engagement is critical to the implementation of sustainability programs and projects in day-to-day operations [18]–[21], and employees need to be aware of the company's sustainability performance goals [22], [23] and change their behavior to contribute to the pursuit of these goals [24], [25]. Recent studies point to the significant impact of employee behavior on corporate sustainability performance [26], [27], e.g., in energy consumption [28], [29] with potential savings of up to 20%-40% of a corporate building's energy consumption [30]–[32].

But how can employees be motivated to adopt sustainable behaviors in the workplace? Previous research has explored a range of measures to

[2]: IPCC (2018)

[3]: NOAA National Centers for Environmental Information (2023)

[4]: Nolan *et al.* (2020)

[5]: Kahle *et al.* (2022)

[6]: UNFCCC (2020)

[7]: Rogelj *et al.* (2016)

[8]: Aguilera *et al.* (2021)
[9]: George *et al.* (2016)
[10]: Williams *et al.* (2019)

[11]: Wood (2022)

[12]: United Nations (2020)

[13]: Delmas *et al.* (2013)

[14]: Whiteman *et al.* (2013)

[15]: Adams *et al.* (2014)
[16]: Hahn *et al.* (2015)

[17]: Ergene *et al.* (2020)

[18]: Wolf (2013)
[19]: Westman *et al.* (2019)
[20]: Kim *et al.* (2017)
[21]: Robertson *et al.* (2013)

[22]: George *et al.* (2021)
[23]: Huber *et al.* (2017)

[24]: Norton *et al.* (2015)
[25]: Ones *et al.* (2012)

[26]: Chen *et al.* (2015)
[27]: Paillé *et al.* (2014)

[28]: Khosrowpour *et al.* (2018)
[29]: Paone *et al.* (2018)

[30]: Sun *et al.* (2017)
[31]: Anand *et al.* (2019)
[32]: Piselli *et al.* (2019)

encourage sustainable behavior among employees. For example, companies can concentrate on recruiting employees with values and beliefs similar to those of the company, developing training programs to improve awareness and knowledge, and implementing reward practices [33]–[35]. Informational posters and stickers may also help promote recycling, energy conservation, and physical activity among employees [36], [37], and leadership practices that serve as role models for followers, such as environmentally transformational leadership [21] and environmentally servant leadership [38] influence employees' green behaviors. Most importantly, digital interventions to promote sustainable employee behavior in organizations with a particular focus on environmentally friendly behavior have received increasing attention as so-called *Green Information Systems (IS)*.

Green IS can be understood as *"IS-enabled organizational practices and processes that improve environmental and economic performance"* [39, p. 2]. Previous work has shown that green IS can successfully encourage employees to engage in sustainable behaviors [40]. Persuasive feedback systems on current energy use [41] and ambient learning displays with information on energy use, conservation tips, and potential savings [42], for example, raise employee awareness of energy use. However, feedback alone lacks critical elements necessary for user engagement [43]: Users cannot adjust goals or receive tailored information [28], [44], nor are they motivated by social or competitive elements [45]. Therefore, green IS increasingly use motivational and social design features to offer their users not only informational benefits, such as feedback but also to induce affective/motivational and social benefits [46]. For instance, Hillebrand and Johannsen [47] designed an interactive climate chatbot and observed that its use promoted a range of environmentally friendly actions, such as eating a vegetarian diet, avoiding waste, and switching off electronic devices. In this respect, *gamification* holds great potential for enhancing positive affective and social experiences in the use of green IS [44], [48].

Gamification can be defined as *"the intentional use of game elements for a gameful experience of non-game tasks and contexts"* [49, p. 17]. Since the beginning of research interest, the predominant application area for gamification has been education [48], [50], [51]. However, researchers in other fields have applied gamification in other areas, such as health, crowdsourcing, informatics, marketing, innovation, transportation, management, and sustainability [48]–[52]. Specifically, in the context of sustainable behaviors, research has explored gamification as a means to promote energy savings in households (e.g., [53]–[55]). In addition, gamification has been used as a means to promote sustainable travel and commuting (e.g., [56]–[58]), sustainable water conservation (e.g., [59]–[61]), eco-friendly driving (e.g., [62]–[64]), green nutrition (e.g., [65]), and recycling (e.g., [66], [67]).

Regarding gamification to promote sustainable employee behavior in the workplace, previous research has focused specifically on how gamified approaches can support employees' physical activity [68], [69] and well-being [70]–[73] in the workplace. In addition, studies examined how gamification can foster innovation in organizations [74]–[77] and how gamified applications may promote energy-saving behaviors among employees at the workplace [78]–[86]. However, most of the 17 SDGs remain unexplored as dimensions of sustainable behavior that could be motivated by gamification in the workplace. For example, few studies focus on the potential

[33]: Dumont *et al.* (2017)
[34]: Sabokro *et al.* (2021)
[35]: Pinzone *et al.* (2019)

[36]: Manika *et al.* (2021)
[37]: Chakravarty *et al.* (2019)

[21]: Robertson *et al.* (2013)

[38]: Afsar *et al.* (2018)

[39]: Melville (2010)

[40]: Singh *et al.* (2020)

[41]: Casado-Mansilla *et al.* (2020)

[42]: Börner *et al.* (2015)

[43]: Spence *et al.* (2018)

[28]: Khosrowpour *et al.* (2018)
[44]: Pasini *et al.* (2017)

[45]: Piche *et al.* (2017)

[46]: Hassan *et al.* (2019)

[47]: Hillebrand *et al.* (2021)

[48]: Koivisto *et al.* (2019)
[49]: Seaborn *et al.* (2015)
[50]: Hamari *et al.* (2014)
[51]: Albertazzi *et al.* (2019)
[52]: Kasurinen *et al.* (2018)

[53]: Fraternali *et al.* (2019)
[54]: Johnson *et al.* (2017)
[55]: Morganti *et al.* (2017)

[56]: Andersson *et al.* (2018)
[57]: Lieberoth *et al.* (2018)
[58]: Ferron *et al.* (2019)

[59]: Aubert *et al.* (2019)
[60]: Novak *et al.* (2018)
[61]: Koroleva *et al.* (2020)

[62]: Massoud *et al.* (2019)
[63]: Nousias *et al.* (2019)
[64]: Günther *et al.* (2020)

[65]: Berger (2019)

[66]: Aguiar-Castillo *et al.* (2019)
[67]: González-Briones *et al.* (2019)

[68]: Dadaczynski *et al.* (2017)
[69]: Kouwenhoven-Pasmooij *et al.* (2017)

[70]: Hungerbuehler *et al.* (2021)
[71]: Ladakis *et al.* (2021)
[72]: Waddell *et al.* (2021)
[73]: Cheng *et al.* (2022)

[74]: Agogué *et al.* (2015)
[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[77]: Patricio *et al.* (2022)

[78]: Hafer *et al.* (2017)
[79]: Kaselofsky *et al.* (2020)
[80]: Kotsopoulos *et al.* (2017)
[81]: Kotsopoulos *et al.* (2020)
[82]: Lou *et al.* (2019)
[83]: Lounis *et al.* (2017)
[84]: Oppong-Tawiah *et al.* (2020)
[85]: Stroud *et al.* (2020)
[86]: Iria *et al.* (2020)

contribution of gamification to reduce inequalities in the work environment, promote sustainable commuting [87] or supply chain management [88], and promote responsible consumption of natural resources, including waste management [89] and water conservation in the workplace. Specifically, there is a scarcity of studies and applicable gamified solutions that address more than one specific sustainability issue and thus take a holistic perspective on sustainable behaviors in the workplace.

[87]: Wunsch *et al.* (2016)

[88]: Putz *et al.* (2018)

[89]: Respati *et al.* (2018)

Therefore, this thesis aims to fill this gap by *conceptualizing, designing, and evaluating a gamified intervention that supports employees in sustainable behaviors related to multiple SDGs, such as energy conservation (SDG 7), waste production and recycling (SDG 12), water conservation (SDG 6) and eco-friendly commuting (SDG 11), in their daily activities* and thereby taking a holistic perspective on sustainable behaviors. In line with the call for more design-oriented studies in IS research [90], it adopts a Design Science Research (DSR) approach. This paradigm is best suited for the design and development of artifacts such as systems and applications [91], has been applied in previous studies to develop a gamified application [84], [92]–[94] and closely involves employees in the incremental development of the solution. As part of the iterative design process, the project aims to help *understand the psychological mechanisms of gamification* and gameful design as a basis for designing gamified applications, explore *contextual challenges in implementing such applications* in an organizational context that arise from *employees' motivations, expectations and experiences*, and understand *how gamification influences sustainable employee behavior in organizations*. In addition, the research project aims to provide several *practical contributions to the design of gamification, green IS, and sustainable employee behavior interventions in general*.

[90]: Lehnhoff *et al.* (2021)

[91]: Peffers *et al.* (2007)

[92]: Loock *et al.* (2011)
[93]: Leite *et al.* (2016)
[94]: Beinke *et al.* (2017)

## 1.2 Structure of the Thesis

The structure of this dissertation follows the DSR paradigm, which is explained in more detail in Chapter 2, and is illustrated in Figure 1.1. After the motivation presented in Section 1.1 and the structure of the dissertation outlined in the current section, publications related to this dissertation are listed in Section 1.3.

Then, in Chapter 2, the DSR paradigm, the research approach, and the detailed research questions and corresponding methods for data collection and analysis are described. Subsequently, the theoretical background for this research project is presented in Chapter 3, and a theoretical framework is developed, which forms the basis for the theoretical direction of the following studies in this thesis.

Afterwards, in Chapter 4, the research problem is comprehensively examined in line with the DSR approach through a systematic review of previous literature in the field of gamification for sustainable employee behavior.

As a basis for the DSR cycles, the comprehensive analysis of the theoretical knowledge base for gamified application design is presented in Chapters 5 and 6 in the form of systematic reviews on theoretical (Chapter 5) and empirical (Chapter 6) design principles for gamification.

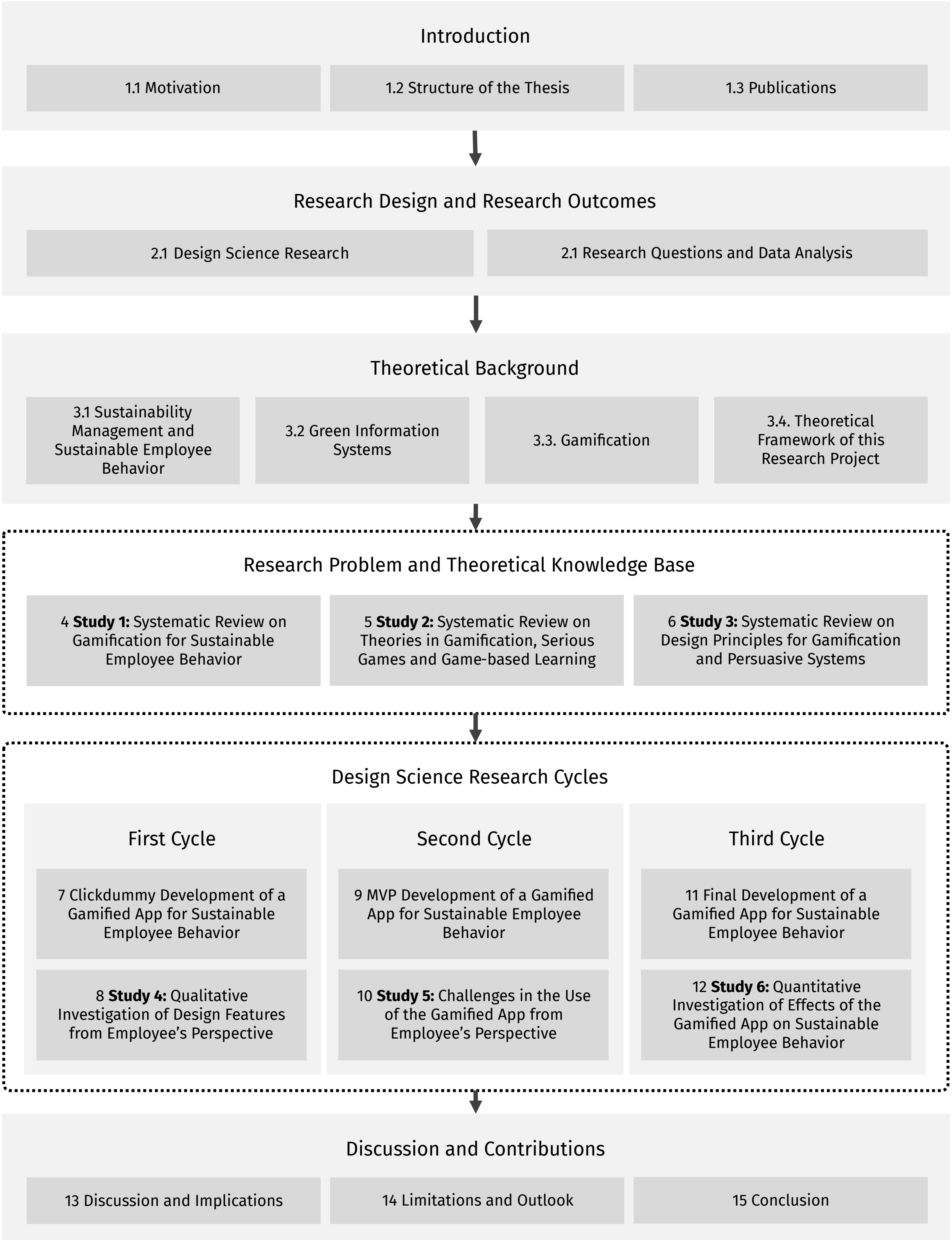


Figure 1.1: Structure of this thesis.

In the following, Chapters 7 to 12 describe the iterative process of design and evaluation, first in the form of a non-functional click dummy formatively evaluated through semi-structured individual interviews with employees (Chapter 7 and Chapter 8), then in the form of a Minimum

Viable Product (MVP) which is formatively evaluated through focus group interviews with employees who tested the application for a short period of time (Chapter 9 and Chapter 10), and finally, in the form of the final gamified application, which is summatively evaluated in a quantitative long-term field experiment (Chapter 11 and Chapter 12).

Finally, Chapters 13 through 15 discuss the contributions and implications (Chapter 13) as well as the limitations (Chapter 14) of this work, followed by concluding remarks (Chapter 15).

## 1.3 Publications

This dissertation is a comprehensive account of the research that the author has conducted over the past three years. Some parts of this dissertation have already been published in peer-reviewed journals or presented at conferences. The following publications are directly related to the contributions of this dissertation:

**J. Krath**, B. Morschheuser, N. Xi, H. F. O. von Korflesch, and J. Hamari, "Challenges in the adoption of sustainability information systems : a study on green IS in organizations", Int. J. Inf. Manag., under review.

**J. Krath**, B. Morschheuser, H. F. O. von Korflesch, and J. Hamari, "How to increase sustainable engagement in the workplace through green IS: the role of instructional and motivational design features", in Thirty-first European Conference on Information Systems (ECIS 2023), Kristiansand, Norway, Jun. 2023, p. 244, `https://aisel.aisnet.org/ecis2023_rp/244/`. [95]

**J. Krath**, B. Morschheuser, and H. F. O. von Korflesch, "Designing Gamification for Sustainable Employee Behavior: Insights on Employee Motivations, Design Features and Gamification Elements", in 55th Hawaii International Conference on System Sciences (HICSS), [Online], Jan. 2022, pp. 1594–1603, `http://hdl.handle.net/10125/79530`. [96]

**J. Krath**, "Gamification for Sustainable Employee Behavior", in Extended Abstracts of the 2021 Annual Symposium on Computer-Human Interaction in Play, [Online], Oct. 2021, pp. 411–414, `https://doi.org/10.1145/3450337.3483523`. [97]

**J. Krath**, L. Schürmann, and H. F. O. von Korflesch, "Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning", Comput. Human Behav., vol. 125, p. 106963, Dec. 2021, `https://doi.org/10.1016/j.chb.2021.106963`. [98]

**J. Krath** and H. F. O. von Korflesch, "Designing gamification and persuasive systems: a systematic literature review", in 5th International GamiFIN Conference, [Online], Apr. 2021, pp. 100–109, `https://ceur-ws.org/Vol-2883`. [1]

A complete list of the author's publications can be found in the Appendix.

# Research Design and Research Questions 2



Against the background of the previously elaborated research need, the overarching goal of this thesis is to investigate the potential of gamification to motivate sustainable employee behavior at work. Extending the focus of previous studies in this area, the goal is to conceptualize, design, and evaluate a gamified intervention that supports employees in various sustainable behaviors in their daily activities.

**Research goal:** *Investigate the potential of gamification to motivate sustainable employee behavior at work.*


Figure 2.1: SDGs that this research project aims to support [12].

[12]: United Nations (2020)

The planned intervention is located in the environmental domain of sustainable development and aims to support companies in addressing the urgent demands to reduce the environmental impact of their operations. It aims to contribute towards advancing sustainable employee behaviors related to SDGs[1] that focus on the *ecological domain* of sustainable development and can be implemented in the *workplace environment*. Concretely, thus, it addresses SDGs *6: Clean Water and Sanitation* (specifically 6.4), *7: Affordable and Clean Energy* (specifically 7.3), *11: Sustainable Cities and Communities* (specifically 11.2), and *12: Responsible Consumption and Production* (specifically 12.5, 12.6, and 12.8). In itself, the intervention represents a measure to educate people about sustainable lifestyles (*SDG 4: Quality Education*, specifically 4.7) as well as to mitigate climate change (*SDG 13: Climate Action*, specifically 13.3), and presents an innovative technology to reduce CO2 emissions in businesses (*SDG 9: Industry, Innovation and Infrastructure*, specifically 9.4).

To pursue this research goal, the DSR paradigm is adopted to answer several research questions and iteratively develop the gamified intervention.

## 2.1 Design Science Research

DSR is best suited for the design and construction of employable artifacts such as systems and applications [91] and has been adopted in multiple previous studies to develop a gamified application [84], [92]–[94]. Influential methodological frameworks in the domain of DSR [99] are the *IS research framework* [100], the *DSR method process model* [91] and the *design research cycle* [101].Table 2.1 presents an overview of these common frameworks and juxtaposes their iterative design steps in a simplified manner, in accordance with the comparison by Venable et al. [102].

[91]: Peffers *et al.* (2007)

[84]: Oppong-Tawiah *et al.* (2020)
[92]: Loock *et al.* (2011)
[93]: Leite *et al.* (2016)
[94]: Beinke *et al.* (2017)

[99]: Hevner *et al.* (2010)

[100]: Hevner *et al.* (2004)

[101]: Kuechler *et al.* (2012)

[102]: Venable *et al.* (2017)

DSR starts with an initial problem definition from the environment that provides relevance [100], and is also called problem identification [91] or problem awareness [101]. The theoretical knowledge base composed of foundations, methodologies and previous research findings informs

[1] SDG icons taken from `https://www.un.org/sustainabledevelopment/`. The content of this publication has not been approved by the United Nations and does not reflect the views of the United Nations or its officials or Member States.

Table 2.1: Comparison of iterative steps in common DSR frameworks, in accordance with [102].

| Author | Hevner et al. [100] | Peffers et al. [91] | Kuechler et al. [101] |
|---|---|---|---|
| First step | Problem definition / relevance | Problem identification | Problem awareness |
| Second step | - | Definition of objectives | Suggestion |
| Third step | Building | Design & development | Development |
| Fourth step | - | Demonstration | - |
| Fifth step | Evaluation | Evaluation | Evaluation |
| Sixth step | Contribution to theory | Communication | Conclusion |

the design process [100], [101], where first, objectives [91] or suggestions [101] for a design solution are formulated. Subsequent development [91], [101] or building [100] is followed by a demonstration of the artifact in a suitable context [91] and an evaluation of the artifact [91], [100], [101]. The insights or conclusions from the evaluation, which are communicated to the scholarly community [91], [101], lead to refinement of the theory [100] or objectives [91] and enhance problem awareness [101], paving the way for the next design iteration.

[91]: Peffers *et al.* (2007)
[100]: Hevner *et al.* (2004)
[101]: Kuechler *et al.* (2012)

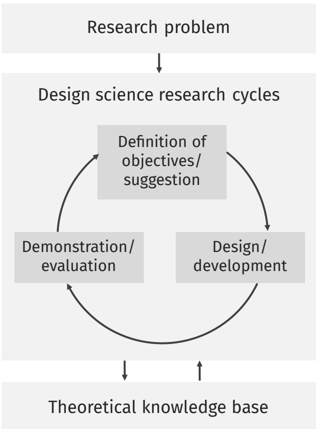


Figure 2.2: The general nature of DSR (after [91], [100], [101]).

Although they differ slightly in naming the research steps, all three frameworks emphasize the iterative nature of DSR and the ongoing link between theory and IS design. Thus, the general nature of DSR consists of a *research problem* and *theoretically informed* DSR cycles composed of the *definition of objectives/suggestion*, followed by the *design/development* and ending with the *demonstration/evaluation* that contributes to theoretical knowledge and to redefining the objectives and suggestions (see Figure 2.2).

In addition to the DSR methodology, this investigation follows the *Human Risk & Effectiveness evaluation strategy of the Framework for Evaluation in Design Science Research (FEDS)* [103] for the selection of evaluation methods after each design cycle. This strategy is most appropriate when the primary design risk is social/user-centric and when a critical goal is to ensure that the artifact's utility in real-world situations persists over the long term [103]. In general, this strategy suggests that an artifact should first be evaluated in an artificial environment with formative evaluations that provide deep insights into individuals' experiences with the artifact, and then gradually move to summative evaluations in the real environment (naturalistic) that aim to explore the effects of the artifact in further design cycles [103]. Unlike other evaluation strategies, the Human Risk & Effectiveness strategy emphasizes artificial and naturalistic formative evaluations before moving to summative evaluations, focusing on the contextual factors that affect the use of the artifact from the users' perspective, rather than merely concentrating on the artifact itself [103].

[103]: Venable *et al.* (2016)

Accordingly, beyond theoretical research that forms the knowledge base for the definition of suggestions in the first DSR cycle, several design cycles with empirical evaluations will be conducted (see Table 2.2). First, qualitative research based on an abstracted artifact (i.e., a non-functional click dummy) is carried out in the form of interpretive semi-structured individual interviews with a target group of employees to understand their perspective on the artifact improve the design of the artifact [103]. Second, based on the findings from the initial evaluation, the artifact is further developed (i.e., a functional MVP), followed by a naturalistic qualitative evaluation through focus group interviews with employees who have used the artifact in the real-world environment over a limited

| FEDS approach [103] | Method |
|---|---|
| F, A | Individual semi-structured interviews |
| F, N | Focus group interviews |
| S, N | Quantitative survey, log data, key measures |

**Table 2.2:** Evaluation strategy of the research project (A = artificial, N = naturalistic, F = formative, S = summative).

period of time. Third, following the development of the artifact based on the learnings in the second evaluation (i.e., a functional application), a quantitative, summative - assessing the extent to which the results meet expectations [103] - evaluation of the artifact in the real-world environment is conducted over an extended period of time to draw conclusions about the effectiveness of the artifact in motivating sustainable employee behavior at work.

[103]: Venable *et al.* (2016)

In doing so, the empirical evaluations iteratively generate further knowledge about the requirements for the design of the gamified application, which strengthens the link between theoretical insights and practical design processes that are integral to DSR [91], [100], [101].

[91]: Peffers *et al.* (2007)
[100]: Hevner *et al.* (2004)
[101]: Kuechler *et al.* (2012)

## 2.2 Research Questions and Data Analysis

### 2.2.1 Research Problem

The research problem identified in this thesis is the lack of holistic, applicable solutions to motivate different sustainable behaviors of employees at work that collectively add to the company's contribution to sustainable development. Specifically, gamification is explored and evaluated as a possible approach to designing a green IS that could solve this research problem. The overview of the research model in line with the general nature of DSR (Figure 2.2) and the evaluation strategy described (Table 2.2) is presented in Figure 2.3.

**Research problem:** *Lack of applicable solutions to motivate different sustainable behaviors of employees at work that collectively add to the company's contribution to sustainable development.*

To gain a *deep understanding of the research problem* before beginning the first iteration of DSR, the first research step consists of a systematic review of previous work on gamification for sustainable employee behavior in the workplace. Five research questions are posed based on the theoretical framework of this research project, which consists of gamification design theory, gamification design elements, and the psychological, behavioral, and corporate outcomes of gamification and green IS in the workplace, discussed in more detail in Chapter 3. The research questions are answered through a concept-centered literature review based on Webster and Watson's [104], King's [105] and Paré's [106] methodological suggestions for narrative reviews. In addition, the Reporting Standards for Systematic Evidence Syntheses (ROSES) [107], which evolves the widely accepted Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standard for meta-analyses from medical research focused on quantitative data syntheses [108] into a new standard for narrative, qualitative, and mixed methods syntheses, guided the selection and screening process.

[104]: Webster *et al.* (2002)

[106]: Paré *et al.* (2015)

[107]: Haddaway *et al.* (2018)

[108]: Moher *et al.* (2009)

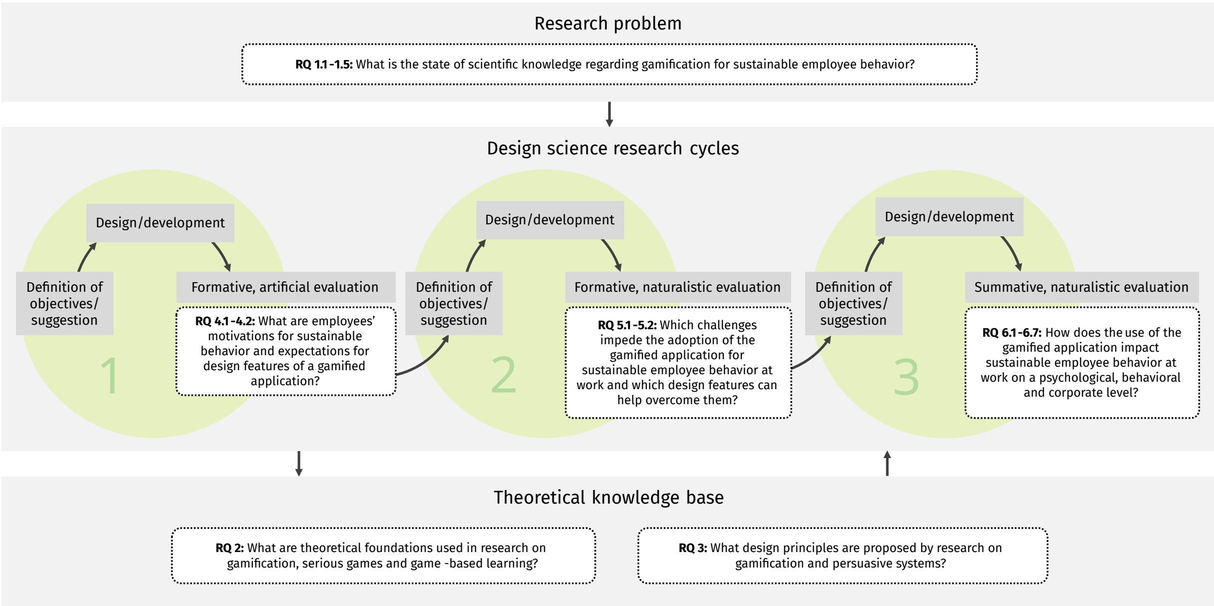


Figure 2.3: DSR research model of the present work.

**RQ 1.1:** *Which theories have been employed in studies on gamification for sustainable employee behavior?*

**RQ 1.2:** *Which game design elements have been used in studies on gamification for sustainable employee behavior?*

**RQ 1.3:** *Which psychological outcomes have been identified in studies on gamification for sustainable employee behavior?*

**RQ 1.4:** *Which behavioral outcomes have been identified in studies on gamification for sustainable employee behavior?*

**RQ 1.5:** *Which corporate outcomes have been identified in studies on gamification for sustainable employee behavior?*

## 2.2.2 Theoretical Knowledge Base

Second, a thorough consideration of existing theoretical knowledge is required for the definition of objectives and suggestions in the first DSR cycle [91], [101].

[91]: Peffers *et al.* (2007)
[101]: Kuechler *et al.* (2012)

[109]: Landers *et al.* (2019)

Landers [109] argues that legitimate gamification incorporates insights from psychological research and research on game design and human-computer interaction to motivate new behaviors in a *"consistent, generalizable, ethical, and theoretically justifiable way."* [109, p. 2]. Accordingly, an important theoretical basis for the design of the gamified application consists of the theoretical foundations that explain why and how gamification is effective in influencing and motivating specific behaviors beyond the specific context of workplace sustainability explored in **RQ 1.1-1.5**. Although considerable research efforts have already been made to investigate whether gamification leads to noticeable benefits, several researchers criticize insufficient knowledge about the psychological mechanisms that explain how gamification achieves these benefits [48], [110], [111]. Notably, academic studies have recently begun to use theoretical foundations to design, explain, and evaluate their gamified interventions. However, existing reviews do not fully capture the variety of theories that have been used in different contexts. For example, Seaborn and Fels [49] note the use of Self-Determination Theory (SDT) [112], situational relevance theory [113] and the Transtheoretical Model of Behavior Change (TTM) [114] as predominant foundations in primary gamification studies, whereas Martí-Parreno et al. [115] cite cognitive load theory [116], the ARCS motivational model [117] and the Technology Acceptance Model (TAM) [118] as important theoretical foundations in gamification research. Dichev and Dicheva [119], on the other hand, review gamification in an educational context and emphasize Lander's theory of gamified learning [120] as an important theoretical treatise in scientific studies. Thus, in terms of the theoretical foundations of gamification, these findings illustrate the controversy and lack of an overview of a) the theories used as the basis for scientific research on gamification in different contexts and b) their implications for explaining how gamification achieves the observed positive outcomes.

[48]: Koivisto *et al.* (2019)
[110]: Sailer *et al.* (2020)
[111]: Nacke *et al.* (2017)

[49]: Seaborn *et al.* (2015)

[112]: Ryan *et al.* (2000)

[113]: Wilson (1973)

[114]: Prochaska *et al.* (1997)

[115]: Martí-Parreño *et al.* (2016)

[116]: Sweller (1988)

[117]: Keller (1987)

[118]: Davis (1989)

[119]: Dichev *et al.* (2017)

[120]: Landers (2014)

Consequently, a systematic literature review is conducted to identify the theoretical foundations of gamification through a meta-review [106], [121] of existing reviews on gamification, serious games, and game-based learning, with the goal of synthesizing the findings of previous studies and finding core concepts or theories that provide new or stronger explanations for the psychological mechanisms of gameful design [122]. The meta-review is performed according to the ROSES standard [107].

[106]: Paré *et al.* (2015)
[121]: Gough *et al.* (2017)

[122]: Thorne *et al.* (2004)

[107]: Haddaway *et al.* (2018)

Accordingly, the following research question is posed:

> **RQ 2:** *What are theoretical foundations used in research on gamification, serious games and game-based learning?*

In addition, scholars from various fields have proposed several gamification design principles for developing a gamified application [84], [123], [124]. Guidelines and design strategies for persuasive systems, which are a broader concept than gamification but similarly designed to change or shape attitudes or behaviors and thus closely related to gamification systems [125], have also been developed and proposed by several researchers [126]–[128]. In order to derive theoretically grounded design principles for the first DSR cycle, these existing proposals are analyzed, compared, and synthesized with the findings from the previous review of theoretical foundations as a basis for developing a theoretically sound design suggestion for the gamified application.

[84]: Oppong-Tawiah *et al.* (2020)
[123]: Morschheuser *et al.* (2018)
[124]: Liu *et al.* (2017)

[125]: Bui *et al.* (2015)

[126]: Oinas-Kukkonen *et al.* (2009)
[127]: Haller *et al.* (2017)
[128]: Orji *et al.* (2019)

The according research question is formulated as follows:

> **RQ 3:** *What design principles are proposed by research on gamification and persuasive systems?*

### 2.2.3 Design Science Research Cycles

Based on the synthesis of the theoretical knowledge gained from the preceding reviews, the first set of suggestions for the gamified application is formulated and implemented in the form of a non-functional click dummy that shows ideas for elements and structure in the realization of the application. The first evaluation, following the FEDS strategy, starts by showing this click dummy to a target group of employees from different companies, i.e., an artificial and formative evaluation focused on gaining insights into design hypotheses and providing a basis for improving the artifact [103]. The main goal of this evaluation is to understand the individual dispositions and expectations of employees that need to be considered in the further design of the gamified application based on this initial, artificial artifact. For data collection, semi-structured interviews are best suited to gather such in-depth information about individuals' personal affairs [129]. The research questions to be answered by this initial evaluation are:

[103]: Venable *et al.* (2016)

[129]: DiCicco-Bloom *et al.* (2006)

**RQ 4.1:** *What are employees' motivations for sustainable behavior at work?*

**RQ 4.2:** *What are employees' expectations for design features of a gamified application to support sustainable behavior at work?*

Based on the new insights into the motivations and expectations of the employees, the second DSR cycle starts with the refinement of the existing suggestions for the design of the gamified application.

**App development frameworks.**

You can find more information on the different app development frameworks noted in the text on the respective websites:

- ReactNative: `https://reactnative.dev/`
- Ionic: `https://ionicframework.com/`
- Flutter: `https://flutter.dev/`
- NativeScript: `https://nativescript.org/`

Then, based on the refined suggestions and the developed click dummy from the first cycle, a functional MVP of the gamified application is implemented for the platforms (e.g., Android, iOS, macOS, Windows) identified as most relevant in the individual interviews. For developing apps that are usable on different systems with only one code base, there are several cross-platform app development frameworks, such as Meta's *ReactNative*, Drifty Co's *Ionic*, Google's *Flutter*, and nStudio's *NativeScript*, that are widely used and therefore provide good documentation and large communities. Since the tools use different programming languages for business logic and user interface design, the selection of a framework follows an evaluation of complexity and maintainability, as well as capabilities offered to implement the defined requirements.

The second DSR cycle ends with a naturalistic (in a real-world environment) and formative evaluation [103] by introducing the gamified application to several case companies and conducting a qualitative evaluation after three weeks of use. Previous research on green IS has highlighted the need to explore obstacles and challenges to green IS adoption in the workplace and to understand how systems need to be designed to account for the individual adoption process. The main goal of this evaluation is thus to gain deep insights into employees' experiences using the gamified application, with a particular focus on the challenges they encountered during use and their ideas on how to overcome these challenges in the design. Focus group interviews are chosen as the data collection method for this evaluation given their synergistic potential [130] to provide data through the sharing and comparison of experiences [131] that is rarely obtained

[130]: Adams *et al.* (2008)

[131]: Bruseberg *et al.* (2002)

through individual interviews and observation, resulting in particularly powerful findings [132]. The research questions to be answered by this evaluation are:

[132]: Kamberelis *et al.* (2013)

**RQ 5.1:** *Which challenges impede the adoption of the gamified application for sustainable employee behavior at work?*

**RQ 5.2:** *Which design features can help overcome these challenges?*

The results of the preceding evaluation lead to the refinement of the suggestions for the gamified application as the beginning of the third and final DSR cycle, in which the actual impact of the gamified application in motivating sustainable employee behavior at work is investigated. After the second iteration of the implementation, in which the application is further developed and improved by the findings from the second evaluation, a field experiment is carried out. The gamified application is introduced in seven companies from different industries and two universities for a period of six months. To examine the impact of the gamified application, the evaluation, which is naturalistic and summative in design [103], triangulates findings from employee surveys, log data from the gamified application, and corporate sustainability measures to infer impacts on psychological, behavioral, and corporate outcomes, in line with the theoretical framework of this research project presented in Chapter 3.

[103]: Venable *et al.* (2016)

First, because this study is one of the first to examine the outcomes of gamification for sustainable employee behavior over a longer period of time than most previous, short-term interventions, which lasted between one and seven weeks [78], [82], [84], [87], the initial research question is to investigate how long employees participate in the intervention and use the gamified application in their daily work, especially since previous studies have drawn attention to a possible novelty effect of gamification [48]. The research question is posed as follows:

[78]: Hafer *et al.* (2017)
[82]: Lou *et al.* (2019)
[84]: Oppong-Tawiah *et al.* (2020)
[87]: Wunsch *et al.* (2016)

[48]: Koivisto *et al.* (2019)

**RQ 6.1:** *How does employees' use of the gamified application evolve over time?*

Second, for *psychological* outcomes, employees are asked to complete a quantitative survey on determinants and self-perceptions of sustainable behavior at the beginning of using the gamified application and at recurring two-month intervals. The theoretical model of sustainable behavior explored in this analysis is based on goal-framing theory [133] and the Theory of Planned Behavior (TPB) [134], both popular theories in explaining sustainable employee behavior [135], [136] to understand the process of how the application influences employees' self-reported sustainable behavior at work. In addition, employees are surveyed about their experiences with the gamified application to supplement the quantitative results with qualitative explanatory data. In a within-subject design, the following research questions are to be answered through this analysis:

[133]: Lindenberg *et al.* (2013)

[134]: Ajzen (1985)

[135]: Bamberg *et al.* (2007)
[136]: Canto *et al.* (2023)

**RQ 6.2:** *How does the use of the gamified application influence antecedents and self-report sustainable employee behavior?*

**RQ 6.3:** *How do employees subjectively experience using the gamified application to support them in sustainable behaviors at work?*

Third, for *behavioral* outcomes, log data of the in-app behavior of employees is collected over the entire usage period. Specifically, the number of in-app sustainability actions performed serves as a measure of observed sustainable behavior, while clicks on various design features serve as a measure of usage of various gamification design elements. Thus, the analysis of in-app behavior complements the findings from the psychological analysis by helping to understand how different design features influence the antecedents of both self-reported and observed sustainable behavior of employees at work. The research questions to be answered through Structural Equation Modeling (SEM) are:

**RQ 6.4:** *How does the use of different design features of the gamified application influence observed sustainable employee behavior?*

**RQ 6.5:** *How does the use of different design features of the gamified application influence antecedents and self-report sustainable employee behavior?*

Finally, various metrics such as monthly water, gas and electricity consumption in company buildings, emissions from business travel and the amount of waste generated by employee activities are collected for investigating *corporate* outcomes during the field experiment. In order to exclude seasonal deviations, the metrics for the same period as the field experiment period of the previous year are used as comparative values. In a comparative within-and between-subject design, this analysis aims to answer the following research questions:

**RQ 6.6:** *Which effects does the use of the gamified application have on corporate sustainability measures?*

**RQ 6.7:** *Are there differences in the effect of the gamified application between companies of different industries and sizes?*

The conclusions and communications of the research findings aim to provide the following theoretical contributions to the research fields of gamification, green IS and sustainable employee behavior:

- Understanding of the psychological mechanisms of gamification and gameful design
- Understanding of the contextual challenges of implementing green IS in an organizational context, arising from employee motivations, expectations, and experiences
- Understanding of how gamification and green IS (design) influences sustainable employee behavior in organizations

In addition, the research project aims to yield several practical contributions for the design of gamification, green IS and interventions for sustainable employee behavior in general:

- Design principles for gamification and persuasive systems in general
- Design recommendations for gamification for sustainability and green IS in organizational settings in particular
- Guidance for selecting (gameful) design features to motivate sustainable employee behaviors at work

# Theoretical Foundations

# 3 Theoretical Background



This research project, which aims to explore the potential of gamification, in particular a gamified application, to motivate sustainable employee behavior at work, builds on and contributes to three interrelated research streams and combines perspectives from their domains (see Figure 3.1).

First, from a management perspective, the current project is situated in the field of *sustainability management*, particularly at the operational level, i.e., activities that relate to everyday decisions and actions of employees in organizations [137]. Second, from an IS perspective, the project is in the area of *green IS*, which designates IS in support of environmental sustainability [40]. And third, from a human-computer interaction perspective, the project is positioned in the realm of *gamification*, which refers to the use of gameful design elements to create positive affective experiences in support of utilitarian outcomes [48].

[137]: Loorbach *et al.* (2010)

[40]: Singh *et al.* (2020)

[48]: Koivisto *et al.* (2019)

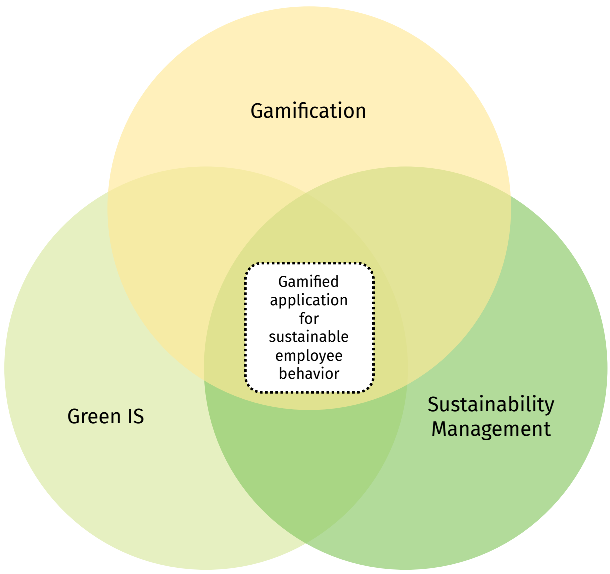


Figure 3.1: Research streams on which this research project builds and to which it contributes.

All of these perspectives are equally valuable for investigating the potential of gamification for sustainable employee behavior to provide background knowledge for designing a gamified artifact and a theoretical understanding of the phenomena of adoption, use, and effects of gamification for sustainable employee behavior in the workplace. In the following, each of the three research strands is presented in detail with its development, definition and understanding, and current scientific knowledge.

## 3.1 Sustainability Management and Sustainable Employee Behavior

*Sustainability* describes a normative concept [138] and refers to a state in which humans can thrive in perpetuity within the ecological limits of the

[138]: Williams *et al.* (2017)

planet, along with other living things [139]. Since sustainability is never a final state that can be achieved, but a moving goal [140], each human generation has a responsibility to contribute to *sustainable development* for the benefit of future generations. Sustainable development can be defined as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* [141, p. 54] and requires efforts at all levels of society, including governments, organizations, and individuals.

[139]: Ehrenfeld (2012)

[140]: Gaziulusoy *et al.* (2013)

[141]: United Nations General Assembly (1987)

In this context, the United Nations SDGs[2] (Figure 3.2) were created as an international framework to guide activities to achieve sustainable development [12]. In line with the concept of the triple bottom line [142] or the sustainability triangle [143], these goals refer to sustainable development at the environmental (e.g., SDG 6-7, SDG 11-15), social (e.g., SDG 1-5, SDG 10, SDG 16), and economic (e.g., SDG 8-9, SDG 17) levels.

[12]: United Nations (2020)

[142]: Norman *et al.* (2004)

[143]: Schaltegger (2013)


**Figure 3.2:** An overview of the SDGs [12].

Specifically, companies are increasingly required to contribute to sustainable development, engage in corporate sustainability, and continuously improve their sustainability performance [8]. In this context, research efforts on corporate *sustainability management* have steadily increased in recent years [138]. In general, sustainability management can be understood as *"an activity of managing sustainability issues in organizations"* [143, p. 2384], but often also refers to the people in an organization who carry out sustainability management activities [143]. Sustainability management requires the integration of sustainability aspects into a company's planning, processes, and activities [144]. In a comprehensive review of sustainability management frameworks, Nawaz and Koç summarize that sustainability management involves defining a vision and framework for sustainability in the organization; describing criteria, risks, and objectives; implementing sustainability initiatives; and continuously monitoring them for improvement [145].

[8]: Aguilera *et al.* (2021)

[138]: Williams *et al.* (2017)

[144]: Baumgartner (2014)

Research on corporate sustainability has examined a variety of sustainability management tools [146], [147] that support the realization of sustainability in a company. These can be divided into tools for accounting, sustainability indicators, product design, and communication [146]. Of these, sustainability or environmental reports [146] and environmental management systems [147] have received the most attention.

[145]: Nawaz *et al.* (2018)

[146]: Hörisch *et al.* (2015)
[147]: Johnson *et al.* (2016)

[2] SDG icons taken from `https://www.un.org/sustainabledevelopment/`. The content of this publication has not been approved by the United Nations and does not reflect the views of the United Nations or its officials or Member States.

[18]: Wolf (2013)
[19]: Westman *et al.* (2019)
[20]: Kim *et al.* (2017)
[21]: Robertson *et al.* (2013)
[26]: Chen *et al.* (2015)
[27]: Paillé *et al.* (2014)
[137]: Loorbach *et al.* (2010)

However, employee engagement has been highlighted as a critical factor for successful sustainability implementation [18], [19], and the vast majority of sustainability initiatives rely on employee participation and engagement [20], [21]. Previous research has shown that individual employee sustainable behaviors significantly influence overall corporate sustainability [26], [27]. In this context, the subject of sustainable employee behavior - and how it can be supported by sustainability management initiatives at the operational level [137] - has gained increasing attention.

### 3.1.1 Understanding of Sustainable Employee Behavior

[25]: Ones *et al.* (2012)
[148]: Rubel *et al.* (2021)
[149]: Ateş (2020)

Sustainable employee behavior has traditionally been defined on the basis of sustainable behavior in general with a specific application to the corporate context. As the research field has evolved, a variety of interchangeable terms have emerged, making it difficult to define sustainable employee behavior in a consistent manner, such as *organizational citizenship behavior towards the environment, green behavior, workplace environmentally-friendly behavior, employee* Pro-Environmental Behavior *(PEB), environmentally friendly behavior, ecological behavior, responsible environmental behavior, conservation behavior* or *environmentally conscious behavior* [25], [148], [149].

[150]: Ramus *et al.* (2000)

One of the most popular definitions in research on sustainable employee behavior is that of green employee behavior by Ones and Dilchert [25], who describe it as *"scalable actions and behaviors that employees engage in that are linked with and contribute to or detract from environmental sustainability"* [25, p. 452]. From a more organizational perspective, Ramus and Steger [150] define employee environmental initiative as *"any action taken by an employee that she or he thought would improve environmental performance of the company"* [150, p. 606]. Similarly, Rubel et al. [148] define environmentally friendly employee behavior as *"human behavior that minimized the negative environmental consequences of their activities at the workplace and leads to the sustainable performance of the organizations"* [148, p. 1].

[151]: Lülfs *et al.* (2014)
[152]: Bansal *et al.* (2000)

However, these definitions are limited only to the environmental domain of sustainable behavior, whereas sustainable behavior refers to a more holistic form of behavior that includes other domains such as pro-social behavior [151]. In this context, Lülfs and Hahn [151], following Bansal and Roth [152], define sustainable behavior as *"a set of effective, deliberate, and anticipated actions aimed at accepting responsibility for conservation and preservation of physical and cultural resources. These resources include integrity of animal and plant species, as well as individual and social wellbeing, and safety of present and future human generations."* [151, p. 44-45]. Considering the above definitions, the following understanding of sustainable employee behavior emerges for this research project:

> Sustainable employee behaviors are actions and behaviors of employees in the workplace that are associated with or contribute to the conservation and preservation of physical and cultural resources, thereby improving the sustainable performance of the organization.

These behaviors, according to a popular distinction by Bissin-Olson et al [153], can be both task-related (i.e., within the context of core employee tasks) and proactive (i.e., a more active and change-oriented approach to improving workplace sustainability beyond work tasks).

[153]: Bissing-Olson *et al.* (2013)

## 3.1.2 Determinants of Sustainable Employee Behavior

Both in the field of sustainable employee behavior [151], [154], [155] and in the field of sustainable behavior in general [156], three main theories have been most frequently used in research to explain and study behavioral outcomes: the Value-Belief-Norm Theory (VBN), the Norm Activation Model (NAM) and the Theory of Planned Behavior (TPB).

[151]: Lülfs *et al.* (2014)
[154]: Sabbir *et al.* (2022)
[155]: Unsworth *et al.* (2013)

[156]: Klöckner (2013)

The NAM (Figure 3.3) is most commonly used to explain sustainable behavior when it is assumed that sustainable or environmentally friendly behavior is primarily pro-social or altruistically motivated [135]. Originally described by Schwartz [157], the NAM assumes that for altruistic behavior to occur, personal norms - a sense of moral obligation to act pro-socially [158] - must be activated. For this activation, a person must be aware of the (socially negative) consequences of not performing the behavior and attribute responsibility for their actions to themselves [159].

[135]: Bamberg *et al.* (2007)

[157]: Schwartz (1977)

[158]: Zhang *et al.* (2013)

[159]: Dalvi-Esfahani *et al.* (2017)

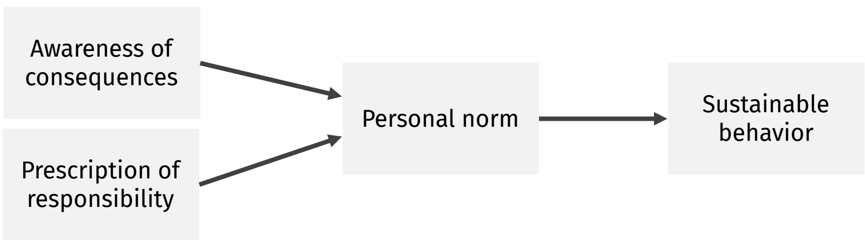


Figure 3.3: The formation of sustainable behavior from the perspective of the NAM, adapted from [157].

The NAM was later extended to the VBN [133], [151], [156] and linked to environmental values [160] (Figure 3.4). In short, VBN explains the activation of personal norms as the result of a norm-building process that begins with one's environmental values - biospheric, humanistic, or egoistic [160], [161] - which influence one's beliefs. These beliefs are the ecological worldview formed by the values, the subsequent awareness of the consequences of not behaving in an environmentally friendly manner, and the attribution of responsibility to behave in an environmentally friendly manner [162]. These beliefs then influence the personal norm and consequently lead to environmentally friendly behavior [162].

[133]: Lindenberg *et al.* (2013)

[160]: Stern *et al.* (1994)
[161]: Stern *et al.* (1995)

[162]: Stern (2000)

In contrast to the social paradigm, TPB (Figure 3.5) is often used as a rational choice theory of sustainable behavior [135]. TPB has been applied in sustainable behavior research since the 1990s [163]. Based on Ajzen and Fishbein's Theory of Reasoned Action (TRA) [164], [165], TPB postulates that an individual's actual behavior depends on his or her behavioral intention, which in turn is determined by three influencing factors: behavioral attitude, subjective norm, and perceived behavioral control [166]. In general, people intend to perform a behavior when they value it positively and when they believe that others expect them to perform it [134], coupled with the subjective belief that they are capable of performing the behavior [166], [167]. Behavioral attitude is based on behavioral beliefs regarding the outcome of the behavior in question (positive or negative), whereas subjective norm depends on normative beliefs regarding the expectations

[163]: Yuriev *et al.* (2020)

[164]: Ajzen *et al.* (1980)
[165]: Fishbein *et al.* (1975)

[134]: Ajzen (1985)

[166]: Ajzen (1991)
[167]: Ajzen (2008)

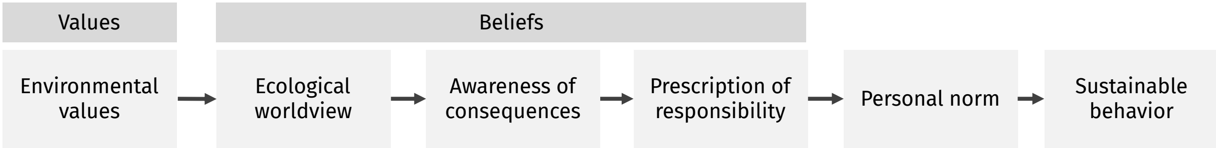


Figure 3.4: The formation of sustainable behavior from the perspective of the VBN, adapted from [162].

of important peers [134] and perceived behavioral control depends on control beliefs [166].

[134]: Ajzen (1985)

[166]: Ajzen (1991)

Meta-analyses of PEB [168] and employee green behavior [169] have consistently confirmed the influence of TPB antecedents on sustainable behavior across studies, and TPB has explained a substantial amount of the variance in pro-environmental behavior in previous studies [155]. Research that has combined VBN and TPB suggests that personal norms and their antecedents from VBN may be another predictor of behavioral intentions in addition to attitudes, subjective norm, and perceived behavioral control in the TPB model [149], [151], [170]–[173].

[168]: Morren *et al.* (2016)

[169]: Katz *et al.* (2022)

[155]: Unsworth *et al.* (2013)

[149]: Ateş (2020)
[151]: Lülfs *et al.* (2014)
[170]: Lülfs *et al.* (2013)
[171]: Han (2015)
[172]: Li *et al.* (2018)
[173]: Blok *et al.* (2015)

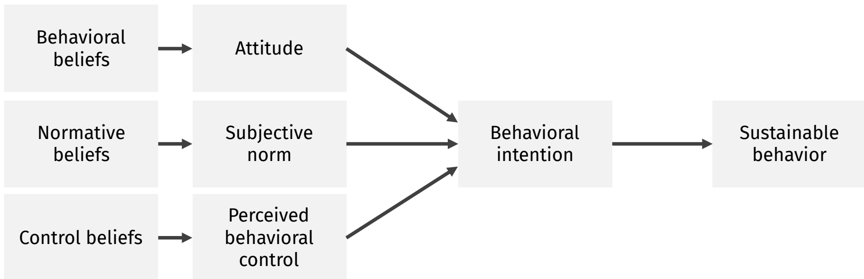


Figure 3.5: The formation of sustainable behavior from the perspective of the TPB, adapted from [166].

However, TPB as a rational choice theory has also been criticized for overlooking crucial aspects that sometimes influence behavior, such as emotions and affect [163]. In an attempt to incorporate these aspects, goal-framing theory [133] has gained attention in research on PEB [136]. It assumes that people are guided by three goal frames: gain goal frames, normative goal frames, and hedonic goal frames. Gain goal frames refer to people's self-interest, i.e., the judgment that environmentally friendly behavior is beneficial from a rational perspective, which refers to the rational choice process established by TPB [133]. Normative goal frames, on the other hand, relate to the belief that sustainable behavior is "the right thing to do" [174], similar to the personal norm established by VBN theory. In addition, goal-framing theory adds hedonic goal frames, which concern affective states and the intention to feel good in the current moment [133]. Rather than behaving sustainably because of perceived benefits or moral obligations, people with an activated hedonic goal frame would seek to behave sustainably when it is enjoyable [174]. Although all goal frames are usually present to evaluate a certain behavior, in most cases one goal is focal and most strongly influences the process of behavior formation [133].

[163]: Yuriev *et al.* (2020)

[133]: Lindenberg *et al.* (2013)

[136]: Canto *et al.* (2023)

[174]: Steg *et al.* (2014)

The main challenge that arises from goal-framing theory is that different goals are often in conflict with each other. Environmentally friendly behavior can often be the right thing to do (normative goal frame), but is not pleasant (hedonic goal frame). Therefore, when attempting to encourage and support sustainable employee behaviors through sustainability management measures, it is important to note that sustainable behaviors may compete with other behaviors or tasks that an employee may choose to engage in [155] and that it is important to develop interventions that align hedonic and gain goals with normative goals [174].

[155]: Unsworth *et al.* (2013)

[174]: Steg *et al.* (2014)

### 3.1.3 Interventions for Sustainable Employee Behavior

Previous research has examined a variety of measures to increase sustainable employee behavior. In general, these can be divided into green Human Resource Management (HRM) practices, marketing, social modeling, participatory approaches, and goal setting and feedback.

*Green HRM practices* include considering sustainability in hiring, training, performance evaluation, compensation, and performance management [175]. For example, companies can focus on recruiting employees with similar environmental values and beliefs as the company, developing training programs to improve awareness and knowledge, and implementing reward practices [33], [34]. Studies show, for instance, that green training [35] and mindfulness training [176] can influence sustainable behaviors of employees in organizations, and rewards appear to have a positive impact on environmentally friendly behaviors in the workplace [155].

[175]: Chen *et al.* (2022)

[33]: Dumont *et al.* (2017)
[34]: Sabokro *et al.* (2021)

[35]: Pinzone *et al.* (2019)

[176]: Geiger *et al.* (2020)

*Marketing interventions* refer to the use of marketing materials, posters, and other internal marketing tools to promote awareness of behavior change within the company. For example, informational posters and stickers can help promote recycling, energy conservation, and physical activity among corporate employees [36], and an energy conservation marketing campaign using posters and stickers as well as pens and T-shirts resulted in significant energy savings at two hospitals [177]. But even in scaled-down form, with only posters acting as green nudges [178], paper use and waste were reduced in companies [37].

[36]: Manika *et al.* (2021)

[177]: Manika *et al.* (2016)

[178]: Schubert (2017)

[37]: Chakravarty *et al.* (2019)

*Social modeling approaches* focus on social influence for employee behavior change. On the one hand, leadership practices that serve as role models for followers, such as environmentally-specific transformational leadership [21] and environmentally-specific servant leadership [38], have been shown to influence employees' green behaviors. On the other hand, defining dedicated "influencers" with the responsibility to encourage colleagues to engage in sustainable behaviors may be an appropriate intervention to promote sustainable employee behaviors, although previous studies have shown mixed effects [179].

[21]: Robertson *et al.* (2013)

[38]: Afsar *et al.* (2018)

[179]: Gregory-Smith *et al.* (2018)

*Participatory approaches* constitute another category of interventions that primarily aim to promote sustainable behavior among employees by giving them a sense of agency and autonomy [180]. For example, participatory workshops with ideation to improve sustainability in the workplace can be an appropriate tool to promote sustainable behaviors [180].

[180]: Endrejat *et al.* (2018)

Finally, *goal-setting and feedback interventions* can be individually targeted tools to support sustainable employee behavior. A study by Davis et al. [181] showed that "eco-cards" containing a set of sustainable behaviors that could be completed and stamped by supervisors could support motivation for sustainable behaviors among employees with low levels of autonomous motivation (whereas, in contrast, the cards undermined motivation among employees who were already autonomously motivated) [181].

[181]: Davis *et al.* (2020)

Goal setting and feedback are also commonly used in digital systems to promote sustainable behavior among employees, such as ambient displays and devices with eco-feedback [41], [42].

[41]: Casado-Mansilla *et al.* (2020)
[42]: Börner *et al.* (2015)

Such digital interventions to promote sustainable employee behavior in organizations with a particular focus on PEB have received increasing attention as a new line of research in the IS field - *green IS*.

## 3.2 Green IS

**Publication of this section.**

The content of this section has been partially submitted in a similar form for publication at the International Journal of Information Management.

About a decade ago, seminal articles in the field called for a focus on the central role of IS in transforming the economy and society toward a sustainable future [39], [182], [183]. Since then, research interest in green IS has grown significantly [184] and has expanded to include sub-fields such as understanding green IS, green IS adoption, the impact of green IS initiatives, accompanying measures and policies, and green IS in different countries [40]. Today, green IS represents a pivotal sub-field in the IS research domain [185].

[39]: Melville (2010)
[182]: Elliot (2011)
[183]: Watson *et al.* (2010)
[184]: El Idrissi *et al.* (2016)
[40]: Singh *et al.* (2020)
[185]: Seidel *et al.* (2017)

### 3.2.1 Understanding of Green IS

To understand green IS, it is important to distinguish green IS from so-called *Green Information Technology (IT)*. The green IT stream examines how and IS can be designed and maintained to be environmentally friendly themselves, so that the environmental impacts of their use (e.g., energy consumption) and disposal are reduced, also referred to as "first-order effects" of and IS on sustainability [186]. In a sense, this stream can also be referred to as the "greening OF IT" [40]. In contrast, the green IS stream is concerned with the potential of IS to support the transition to sustainability by transforming existing processes and behaviors as a possible solution to environmental problems [185], [186], which can also be referred to as "Greening BY IT" [40]. However, despite this distinction, some researchers in the past have also argued that green IT is part of, or even synonymous with, green IS [187].

[186]: Dedrick (2010)

[187]: Shevchuk *et al.* (2019)

The most seminal definitions of green IS were established in the early days of research. In 2010, Melville [39] defined green IS as *"IS-enabled organizational practices and processes that improve environmental and economic performance"* [39, p. 2]. In a broader sense, i.e., not limited to the organizational context and focused more on the research field than the artifact, Jenkin et al. [188] refer to green IS as *"the development and use of information systems to support or enable environmental sustainability initiatives [with an] indirect and positive impact"* [188, p. 18]. In a recent systematic literature review, Singh and Sahu [40] reviewed the definitions of green IS prevalent in academic research and concluded that green IS is *"the effective and efficient IT/S expertise and set of practices focused on plummeting GHGs emission, carbon footprints and ensuring environment sustainability in the society"* [40, p. 3]. To account for the broader transformative potential beyond the organizational context, but to focus on green IS as practices rather than a research topic, the following understanding of green IS is employed for this research project:

[188]: Jenkin *et al.* (2011)

Green IS are IS-enabled practices and processes that support or enable initiatives to improve environmental sustainability in organizations and the society.

In organizations, green IS can serve two roles: a strategic role and an operational role [189]. In the strategic role, green IS are used as a means to optimize business processes and resources [189]. Strategic green IS include, for example, carbon management systems [190], IS to transform offices into smart workplaces [191], IS to implement sustainable supply chain management [192], or IS to green business processes [193]. On the other hand, operational green IS can be catalysts for sustainability transformations at the individual level [189]. Green IS can contribute to shaping beliefs about the environment [39] and facilitating changes in human behavior [194]. Previous research in this area has focused on operational green IS that educate individuals about sustainable behavior choices [184].

[189]: Hedman *et al.* (2016)

[190]: Corbett (2013)

[191]: Papagiannidis *et al.* (2020)

[192]: Camargo Fiorini *et al.* (2017)

[193]: Gohar *et al.* (2020)

[39]: Melville (2010)

[194]: Elliot *et al.* (2001)

[184]: El Idrissi *et al.* (2016)

### 3.2.2 Adoption and Use of Green IS

One of the most important research topics in the field of green IS is how to introduce green IS to people and how to have them adopt them so that they can unfold their positive effects [40], [184], [189], [195]. A variety of previous work has explored critical adoption factors that should be considered when introducing green IS in private (e.g., [196]–[198]) or organizational (e.g., [199]–[201]) contexts.

Much of this prior work draws on existing technology acceptance and adoption models, such as the TAM of [118] (e.g., [196]), the TPB of [166] (e.g., [202], [203]) or the Unified Theory of Acceptance and Use of Technology (UTAUT2) of [204] (e.g., [205]). Other studies added motivational adoption factors aligned with SDT [112], particularly organismic integration theory [187], [198], [202] and the NAM [206]. Further studies examined institutional factors, such as institutional pressure [207], [208], as macro factors influencing individual adoption of green IS. A recent systematic review by [40] shows that research on the adoption of green IS has so far identified 28 critical success factors that affect individual and organizational adoption, which can be categorized as economical, organizational, technological, political-regulatory, ecological, other external and motivational factors (see Table 3.1), with a focus on economical, organizational and regulatory forces [40].

Another stream of research has also explored the role of barriers or challenges (as opposed to drivers or adoption factors) that can be key impediments to the adoption of green IS. While some work interprets challenges as simply failure to meet adoption factors [209], several studies have examined various challenges associated with green IS contexts that offer deeper insights into *why* and *how* adoption fails.

With a particular focus on sustainability compliance, Volkoff et al. [210] examined the challenges of adopting strategic green IS to improve sustainability performance in organizations and found that regularity issues were particularly important. A qualitative study by Jenkin et al. [188] identified four gaps in green IS/IT practices: two of them (knowledge gap and knowledge-doing gap) relate to employee behavior, while the other two

[40]: Singh *et al.* (2020)

[195]: Papagiannidis *et al.* (2022)

[196]: Wunderlich *et al.* (2012)
[197]: Mulcahy *et al.* (2019)
[198]: Wunderlich *et al.* (2019)

[199]: Sahu *et al.* (2016)
[200]: Brooks *et al.* (2018)
[201]: Tooranloo *et al.* (2018)

[118]: Davis (1989)

[196]: Wunderlich *et al.* (2012)

[166]: Ajzen (1991)

[202]: Wati *et al.* (2012)
[203]: Herrenkind *et al.* (2019)

[204]: Venkatesh *et al.* (2012)

[205]: Brauer *et al.* (2016)

[112]: Ryan *et al.* (2000)

[187]: Shevchuk *et al.* (2019)
[198]: Wunderlich *et al.* (2019)

[206]: Dalvi-Esfahani *et al.* (2019)

[207]: Carberry *et al.* (2019)
[208]: Gholami *et al.* (2013)

[209]: Seidel *et al.* (2010)

[210]: Volkoff *et al.* (2011)

[188]: Jenkin *et al.* (2011)

Table 3.1: Critical success factors for green IS adoption [40].

| Category | Critical Success Factors |
|---|---|
| Economical | Cost reduction |
| | Government incentives |
| Organizational | Leadership |
| | Employee stewardship |
| | Capabilities |
| | Structures |
| | Firm size |
| | Organizational climate and culture |
| | IT diffusion |
| | Environmental impact of industry |
| | Commitment, attitude and belief |
| | Competitive strategy and advantage |
| Technological | Interoperability |
| | Relative advantages |
| | Scalability |
| | Reliability |
| | Energy efficient chips |
| | Design |
| Political-regulatory forces | Laws and regulations |
| Ecological forces | Rate of resource renewal |
| | Regenerative capacity of resources |
| Other external forces | Market pressure |
| | Media |
| | Public awareness |
| Motivational factors | Competitiveness |
| | Legitimacy |
| | Social responsibility |
| | Self-motivation |

(practice gap and opportunity gap) relate more to the organization as a whole. In a quantitative confirmatory approach, Sanguinetti et al. [211] observed that lack of knowledge and information, skepticism, and the cost-benefit ratio hindered the adoption of smart home IS in households. In addition, Schmermbeck et al. [212] surveyed representatives of German companies on their perceived reasons for not adopting green IS in their companies and identified that a lack of relevance, resources, and demand combined with unclear benefits were the main reasons for non-adoption. Finally, a recent systematic literature review on the adoption of smart home technology [213] summarized the main technological, financial/ethical/legal and knowledge/psychological resistance barriers that hinder smart home adoption in households.

[211]: Sanguinetti *et al.* (2018)

[212]: Schmermbeck *et al.* (2020)

[213]: Marikyan *et al.* (2019)

Extending the prevailing input (drivers, barriers) - output (adoption, non-adoption) oriented view of green IS adoption, recent studies have taken an individual-oriented perspective on the drivers and challenges of green IS adoption by drawing on procedural models of innovation adoption, such as the Theory of Diffusion of Innovations (DOI) [214]. Schmermbeck et al. [215] analyzed the process of adopting green IS in organizations and identified drivers for adoption in three phases: a pre-adoption phase, a post-adoption phase (use), and a post-adoption phase (continued use). Also, a study by Sanguinetti et al. [211] found from a cognitive rather than organizational perspective that demographic characteristics and perceived

[214]: Rogers (2003)

[215]: Schmermbeck (2019)

benefits and barriers may be able to predict the phase of the innovation decision process in smart home adoption.

### 3.2.3 Effects and Outcomes of Green IS

Especially with regard to operational green IS, which is also the focus of this research project, previous research has already extensively investigated how IS-enabled interventions can support environmentally friendly behavior. Early implementations of green IS include IS-based feedback interventions that have consistently demonstrated significant energy savings in homes and cities [216]. For example, studies have shown that real-time feedback from a smart shower device on energy and water consumption can significantly reduce energy consumption while showering [217], [218]. Nudging can also influence whether people choose a more ecological search engine option [219], especially if the default option is changed. In addition, setting one's own goals in green IS can support individual resource mitigation [216], [220]. In the workplace context in particular, previous work has shown that green IS can successfully encourage employees to adopt sustainable behaviors [40]. For example, persuasive feedback systems on current energy consumption [41] and ambient learning displays with information on energy consumption, savings tips and potential savings [42] promote employee awareness of energy usage. A study by Spence et al. [43] found that using the e-Genie tool, which includes dashboards on energy consumption and trend indicators, as well as hints and tips for energy-saving behaviors, significantly reduced building energy consumption and increased employee energy awareness.

[216]: Loock *et al.* (2013)

[217]: Ableitner *et al.* (2018)
[218]: Tiefenbeck *et al.* (2018)

[219]: Henkel *et al.* (2019)

[220]: Wörner *et al.* (2018)

[40]: Singh *et al.* (2020)

[41]: Casado-Mansilla *et al.* (2020)

[42]: Börner *et al.* (2015)

[43]: Spence *et al.* (2018)

Often, green IS also use motivational and social design features to provide not only informational benefits, such as feedback, for their users, but also to generate affective/motivational and social benefits [46]. Hillebrand and Johannsen [47] designed an interactive climate chatbot and found that its use promoted a range of climate-friendly activities, such as a vegetarian diet, waste reduction, and turning off electronic devices. Using the story of an evolving garden that becomes more beautiful when employees conserve energy, Oppong-Tawiah et al. [84] showed that narrative elements combined with tips and suggestions can significantly reduce energy consumption.

[46]: Hassan *et al.* (2019)

[47]: Hillebrand *et al.* (2021)

[84]: Oppong-Tawiah *et al.* (2020)

In this regard, playful elements represent a particular design avenue to promote positive affective and social experiences in the use of green IS [48] - which points to the potential of *gamification* for the design of green IS.

[48]: Koivisto *et al.* (2019)

## 3.3 Gamification

The background of gamification, e.g., the use of game design and game elements to improve computer interfaces and computer learning programs, can be traced back to occasional papers at human-computer interaction research conferences in the early 1980s [221], but it took until 2010 for the concept of gamification to be first explained in a white paper by Bunchball [222]. Subsequently, interest in gamification as a research topic has raised in the last decade, with the first occasional publications in 2010 and 2011 and an increasing number of studies since 2012 [48]–[52].

[221]: Deterding *et al.* (2011)

[222]: Schöbel *et al.* (2020)

[48]: Koivisto *et al.* (2019)
[49]: Seaborn *et al.* (2015)
[50]: Hamari *et al.* (2014)
[51]: Albertazzi *et al.* (2019)
[52]: Kasurinen *et al.* (2018)

### 3.3.1 Understanding of Gamification

While the term gamification is still debated, there are two definitions of gamification that have emerged as the most popular in academic research [222], [223]. The one by Deterding et al. used in more than 1,800 other publications [223] describes gamification as *"the use of game design elements in a non-game context"* [221, p. 2]. Such game design elements include levels, points, badges, leaderboards, avatars, quests or certificates [224]. On the other hand, from a services marketing perspective, Huotari and Hamari define gamification as *"a process of enhancing a service with affordances for gameful experiences in order to support users' overall value creation"* [225, p. 19] . Two years later, Hamari et al. built on their own definition to expand the marketing perspective to a more general understanding of gamification: *"a process of enhancing services with (motivational) affordances in order to invoke gameful experiences and further behavioral outcomes"* [50, p. 3026].

[222]: Schöbel *et al.* (2020)
[223]: Tobon *et al.* (2020)
[221]: Deterding *et al.* (2011)
[224]: Zainuddin *et al.* (2020)
[225]: Huotari *et al.* (2012)
[50]: Hamari *et al.* (2014)

As opposed to the definition of Deterding et al., Huotari and Hamari argue that their definition focuses on the *utilitarian goals* (value creation / behavioral outcomes) and *psychological outcomes* (gameful experiences) of gamification, rather than on the presence of elements characteristic of games [226], but either definition includes some type of *stimulus* (elements or affordances) used in a *non-game context*, both of which seem essential to the concept of gamification [222]. Tobon, Ruiz-Alba, and García-Madariaga propose a combined definition which assumes that both perspectives on gamification - those that emphasize the elements or stimuli and those that emphasize the psychological outcomes - are pertinent and not mutually exclusive: *"gamification can be defined as a process of applying elements of game design to a non-game context, where the interaction between game mechanisms and personal disposition result in a fun and enjoyable experience"* [223, p. 3]. In a similar vein, Seaborn and Fels [49] combine the definitions of Deterding et al. [221], Huotari and Hamari [225], and Werbach and Hunter [227], who slightly expand Deterding et al.'s definition to include *"the use of game elements and game-design techniques in non-game contexts"* [227, p. 26]. The standard definition they propose is *"the intentional use of game elements for a gameful experience of non-game tasks and contexts"* [49, p. 17].

[226]: Huotari *et al.* (2017)
[49]: Seaborn *et al.* (2015)
[227]: Werbach *et al.* (2012)

In a recent ECIS panel that built on previous definitions of gamification, specifically those of Huotari and Hamari [225], Deterding et al. [221], and Seaborn and Fels [49], researchers agreed to define gamification as *"the use of games, or game design elements in non-entertainment-based contexts - digital as well as non-digital - that is intended to achieve desired outcomes"* [222, p. 7].

To clarify, the different definitions are contrasted in Table 3.2. The commonality of all the definitions presented is that they focus on gamification as a process - rather than the artifact produced. Game-based technology is used for a variety of purposes, such as visualizations and art, but gamification explicitly refers to the process of design [221].

In close alignment with the ECIS panel definition, but acknowledging the difference between outcomes at the psychological or experiential level that subsequently lead to outcomes at the behavioral or utilitarian level [48], the understanding of gamification for this research project is as follows:

[48]: Koivisto *et al.* (2019)

Table 3.2: Common definitions of gamification in chronological order.

| Source | Stimuli | Psychological Outcome | Utilitarian Goal | Context |
|---|---|---|---|---|
| Deterding et al., 2011 [221, p. 2] | game design elements | - | - | non-game context |
| Huotari and Hamari, 2012 [225, p. 19] | affordances | gameful experiences | value creation | service |
| Werbach and Hunter, 2012 [227, p. 26] | game design elements and game-design techniques | - | - | non-game contexts |
| Hamari et al., 2014 [50, p. 3026] | (motivational) affordances | gameful experiences | further behavioral outcomes | service |
| Seaborn and Fels, 2015 [49, p. 17] | game elements | gameful experience | intentional | non-game tasks and contexts |
| Tobon, Ruiz-Alba and García-Madariaga, 2020 [223, p. 3] | elements of game design | fun and enjoyable experience | - | non-game context |
| Schöbel et al., 2020 [222, p. 7] | games or game design elements (digital and non-digital) | - - - desired outcomes - - - | | non-entertainment-based contexts |

Gamification is the use of games or game design elements in non-entertainment-based contexts - digital as well as non-digital - to induce positive psychological outcomes that support desired utilitarian goals.

### Gamification and Play, Games, Serious Games, and Game-based Learning

As the term itself suggests, gamification refers to *gaming* - introduced by Caillois [228] as *ludus* - which involves rules and goal orientation, and contrasts with *play* - *paidia* [228] - which denotes a free, improvisational, and expressive recombination of behaviors [221]. For example, toys that can be used by the player for any conceivable purpose constitute a tool for play, while games (either board games or digital games) with a predetermined set of rules and goals constitute a tool for gaming.

[228]: Caillois (1961)

[221]: Deterding *et al.* (2011)

While classical games such as board games and computer games are merely for entertainment [221] and fun [229], both gamification and *serious games* are used to serve a serious purpose. Deterding et al.'s [221] distinction between serious games as *"full-fledged"* games for non-entertainment purposes and gamified systems that use only game elements is most commonly adopted in academic research [229]–[232]. However, the boundaries can be blurred - for example, there are serious games in which users act in a fictional environment, but this fictional environment is linked to real world circumstances such as actual energy consumption (e.g., [233], [234]). Therefore, serious games can also be considered a particular form of gamification [235], [236]. When gamification or serious games are used in an educational context, the altered learning process is referred to as *game-based learning*, i.e., the achievement of defined learning outcomes through gameful elements and games [237].

[229]: Darejeh *et al.* (2016)
[230]: Groh (2012)
[231]: Uskov *et al.* (2014)
[232]: Shpakova *et al.* (2020)

[233]: Bang *et al.* (2009)
[234]: Takayama *et al.* (2009)

[235]: Kapp (2012)
[236]: Yohannis *et al.* (2014)

[237]: Qian *et al.* (2016)

### Gamification as a Form of Persuasion

The term *persuasion* was coined by Fogg as *"an attempt to change attitudes or behaviors or both"* [238, p. 15] in a voluntary, in contrast to a forced, manner. The design of *persuasive systems* as *"computerized software or information systems designed to reinforce, change or shape attitudes or behaviors or both without using coercion or deception"* [126, p. 486] focuses on increasing users' motivation and ability to perform a target behavior combined with a trigger that elicits that behavior [239]. Elements in persuasive systems are thus intentionally designed to evoke a specific behavior from the user [240]. Game elements can provide a means to achieve persuasion in a particular direction [221] and pursue persuasive strategies [241].

[238]: Fogg (2003)

[126]: Oinas-Kukkonen *et al.* (2009)

[239]: Fogg (2009)

[240]: Albertarelli *et al.* (2015)

[221]: Deterding *et al.* (2011)

[241]: Orji *et al.* (2014)

Although the research streams have developed quite independently, comparison of common gamification elements and persuasive strategies reveals their similarities [125], and even though gamification - unlike persuasion - attempts to influence motivation and user experience rather than behavior directly [242], [243], it can be argued that game-like experiences can promote both motivation and ability from Fogg's behavioral model of persuasive design [244]. Therefore, gamification can act as a specific tool or form of persuasive design [244], [245], [246], albeit persuasion itself is a broader concept than gamification [125].

[125]: Bui *et al.* (2015)

[242]: Hamari *et al.* (2013)
[243]: Hamari *et al.* (2015)

[244]: Werbach (2014)

[245]: Deterding (2014)
[246]: Hamari *et al.* (2014)

### Gamification as a Form of Nudging

The concept of *nudging* emerged in 2009 and was first defined by Thaler and Sunstein [247] as an *"aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives"* [247, p. 6]. Nudges thus aim to change behavior by influencing people's unconscious or habitual approach to decision-making [248].

[247]: Thaler *et al.* (2008)

In this way, nudges are a policy tool that Schubert [178] attempts to categorize into three variants in the context of *green nudges*: self-image focused nudges, social nudges, and default nudges. First, default nudges set specific defaults to direct behavior when people do not actively make a choice, such as offering green energy as a default [178]. Second, self-image nudges focus on supporting the user's desire to maintain an attractive self-image, e.g., by facilitating green behavior through providing information about different choices [178]. Self-image nudging can be performed with gamification mechanisms such as achievements for certain choices to support the persuasive strategy of self-monitoring and suggestion [241]. Third, social nudges exploit people's desire to intimate peer behavior, e.g., by offering peer comparisons [178]. Thus, these social nudges could manifest in leaderboards and status ranks, which are game mechanisms for pursuing the persuasive strategy of competition and comparison [241].

[248]: Ferrari *et al.* (2019)

[178]: Schubert (2017)

Hence, there are parallels between game elements, persuasive strategies and nudges that suggest gamification as a possible form of nudging. Likewise, Hamari and Koivisto [249] mention that gamification has been used in the past to get people to make "good" decisions, which is directly related to the idea of nudging.

[249]: Hamari *et al.* (2015)

### 3.3.2 Design of Gamification

In line with the growing scholarly interest in gamification as a research topic, researchers have proposed a plethora of gamification design frameworks and guidelines to aid in the successful design of gamification [250]. One of the earliest considerations of gamification design distinguishes between different levels of design abstraction [221]: design methods, design models, design principles, and (interface) design patterns, which are similar to motivational affordances [226] (see Figure 3.6).

[250]: Mora *et al.* (2017)

[221]: Deterding *et al.* (2011)

[226]: Huotari *et al.* (2017)

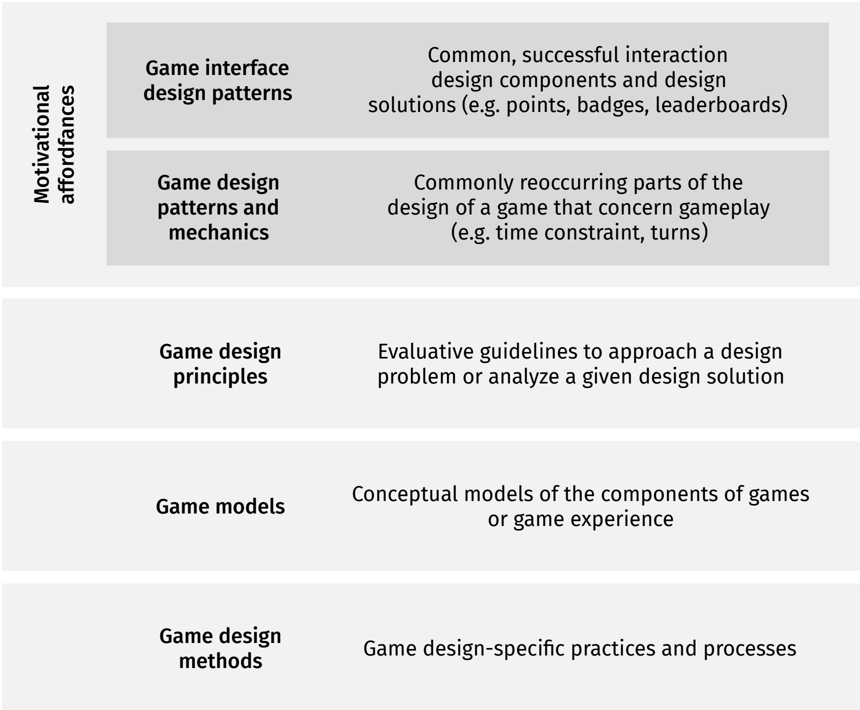


**Figure 3.6:** Levels of game design, based on [221].

Among design *methods*, one of the most popular frameworks [250], which has formed the basis for a variety of other design methods in specific application areas such as education [251] and crowdsourcing [252], is Werbach and Hunter's *6D framework* [227]. The acronym 6D is used to represent the six steps proposed for a successful gamification design process: defining the business goals and expected behaviors, describing the players, devising the activity loops, don't forgetting the fun, and finally deploying the gamification system with the appropriate tools [227]. A comprehensive preparation of the gamification design process through a clear goal definition and an analysis of the users and the context is also emphasized in the gamification design method developed by Morschheuser et al. based on a design science project with game design experts [123]. Compared to Werbach and Hunter [227], they add that iterative rethinking of design and implementation based on the results of continuous evaluation of success is essential for successful gamification design, in line with considerations from DSR [91], [101] and agile development [253].

[251]: Klock *et al.* (2015)

[252]: Brito *et al.* (2015)

[227]: Werbach *et al.* (2012)

[123]: Morschheuser *et al.* (2018)

[91]: Peffers *et al.* (2007)
[101]: Kuechler *et al.* (2012)

For design *models* describing components of the game-like system [221], one of the most popular models [250] is the *Mechanics, Dynamics and Aesthetics Framework (MDA)* framework [254]. It distinguishes between three main components of games: mechanics, which represents the mechanisms of the game at the level of data representation and algorithms, as

[253]: Schwaber *et al.* (2002)

[254]: Hunicke *et al.* (2004)

well as dynamics, which describe the behavior of the mechanics acting on the player's input to create aesthetics, i.e., desired emotional experiences. While game designers often start with the mechanics perspective, the MDA framework suggests that the player perspective should also be taken into account, starting with the aesthetics point of view. Examples of aesthetics include sensation, fantasy, narrative, challenge, fellowship, discovery, expression, and submission [254].

[254]: Hunicke *et al.* (2004)

These aesthetics, in turn, can be achieved through the choice of *game design patterns* (such as time limit and turns) and *game interface design patterns* or game design *elements* [221], [254]. Which game design elements to choose depends on the goals, context, and users [123] and can be guided by design *principles*. A variety of design principles have been proposed by scholars from different disciplines to guide the selection of game design elements, e.g., in health contexts [255], [256], educational contexts [257], [258], and fitness contexts [259]. As a kind of evaluative guide [221], they help decide which elements of game design to focus on, e.g., in fitness contexts, where visualizing progress and providing data for self-monitoring are particularly relevant [259], gamification designers may focus on elements that evoke the experience of challenge [254], such as levels that can be acquired by performing daily workouts.

[221]: Deterding *et al.* (2011)

[123]: Morschheuser *et al.* (2018)

[255]: Wang *et al.* (2019)
[256]: Cafazzo *et al.* (2012)

[257]: Israel *et al.* (2013)
[258]: Plass *et al.* (2015)

[259]: Kappen *et al.* (2016)

Although points, badges, and levels have been prevalent in gamification research since its inception and still are [222], game design elements encompass a much wider variety. The recent comprehensive review of gamification research by Koivisto and Hamari [48] identifies a variety of 45 different *affordances*, i.e., game components that can include both design patterns and interface design patterns and that support the user in achieving the desired behavioral outcome [226], explored in empirical studies of gamification, distinguished into five different categories: achievement and progression (e.g., points, challenges, badges, leaderboards, levels, statistics, status bars, skill trees, and quizzes), social (e.g., social networks, teams, competitions, and voting), immersion (e.g., avatars, narratives, virtual worlds, and role playing), non-digital elements (e.g., rewards, cards, game boards, and die), and other miscellaneous elements (e.g., virtual helpers, reminders, rounds, penalties, and virtual pets).

[222]: Schöbel *et al.* (2020)

[48]: Koivisto *et al.* (2019)

[226]: Huotari *et al.* (2017)

However, adding such gamification elements to a system is not a panacea [111]. As Hamari and Koivisto point out in a seminal article from 2015, successful gamification systems must consider three aspects of the user experience: utilitarian aspects, hedonic aspects, and social aspects [249].

[111]: Nacke *et al.* (2017)

[249]: Hamari *et al.* (2015)

*Utilitarian* aspects often emphasized in theories of technology acceptance from IS research such as the TAM [249] include perceived usefulness of the system, i.e., the perception of the extent to which it enhances or supports the performance of a task [118], and perceived ease of use, which describes the perception of the effort required to use a system [118]. In contrast to purely hedonic systems with the purpose of fun, where such utilitarian aspects are of less importance [260], the success of gamified systems also depends on utilitarian design, so that the experiences intended to be induced by the design [48] are directed toward the intended behavioral or broader utilitarian outcomes. In a sense, playing a strategy game like Anno 2070 to build a green future (an example of storytelling) is not enough to influence players' sustainable behavior in the real world; the gamified system must also provide utilitarian elements that evoke attitudinal change

[118]: Davis (1989)

[260]: Heijden (2004)

[48]: Koivisto *et al.* (2019)

and guide users to change their behavior, such as direct feedback on their behavior in the real world or informational cues.

*Hedonic aspects*, on the other hand, pertain to the experience of enjoyment and fun when using a system [249]. Hedonic elements induce the positive psychological experiences emphasized in several definitions of gamification [49], [50], [223], [225], which are essential as mediators to achieve utilitarian goals. For example, while an application that serves as a coach for sustainable behavior by providing information about sustainable behavior may serve the utilitarian aspect of usefulness, it will not unleash positive psychological experiences unless it includes hedonic elements such as quizzes with playful animations or a virtual avatar that provides emotional motivational messages to engage in behavior change.

[249]: Hamari *et al.* (2015)

[49]: Seaborn *et al.* (2015)
[50]: Hamari *et al.* (2014)
[223]: Tobon *et al.* (2020)
[225]: Huotari *et al.* (2012)

Finally, *social aspects* refer to the inherent embeddedness of human motivation and behavior formation processes in the social context. Social aspects can include, first, to social influence [166], i.e., perceptions of how relatives and peers use the system or expect oneself to use it [249]. In particular, competitive and socially comparative elements, such as leaderboards, can elicit feelings of social norms toward behavior change and thus support utilitarian outcomes. Social aspects, on the contrary, include relatedness [249], which refers to the psychological need for connection and social interaction with others [261]. Working together in teams or feeling recognized by others when presenting one's accomplishments and being praised can satisfy feelings of relatedness, thereby promoting intrinsic motivation for further behavior change [112].

[166]: Ajzen (1991)

[261]: Ryan *et al.* (2017)

[112]: Ryan *et al.* (2000)

**Publication of this subsection.**

The content of this subsection has been partially published in a similar form in [98] J. Krath, L. Schürmann, and H. F. O. von Korflesch, "Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning", Comput. Human Behav., vol. 125, p. 106963, Dec. 2021, doi: `10.1016/j.chb.2021.106963`.

In summary, research has shown that successful gamification design depends on a structured design process that acknowledges iterative development and builds on evaluative design principles in the design phase to select appropriate design elements that fulfill utilitarian, hedonic, and social aspects of the user experience, which are then implemented through appropriate dynamics and mechanics. In this way, the design elements induce positive psychological experiences that support the intended utilitarian outcomes.

### 3.3.3 Effects and Outcomes of Gamification

The predominant application area for gamification since the beginning of research interest has been education, i.e. game-based learning [48], [50], [51]. However, scholars in other fields have swiftly noticed the interesting new concept and applied it in other areas, such as health, crowdsourcing, computer science, marketing, innovation, transportation, management, and sustainability [48]–[50], [51], [52].

[51]: Albertazzi *et al.* (2019)
[52]: Kasurinen *et al.* (2018)

In a general conceptualization of gamification (Figure 3.7), Koivisto and Hamari distinguish between psychological and behavioral outcomes invoked by gameful affordances [48]. Psychological outcomes include, for example, enjoyment, flow, autonomy, and mastery, while behavioral outcomes may be healthy behavior and exercise, participation in learning activities, or completion of a purchase [48]. In learning contexts in particular, researchers typically distinguish between behavioral outcomes, (cognitive) learning outcomes, and either affective outcomes [262], [263], motivational outcomes [110], or both [264], [265] as forms of psychological

[48]: Koivisto *et al.* (2019)

[262]: Carenys *et al.* (2016)
[263]: Lamb *et al.* (2018)

[110]: Sailer *et al.* (2020)

[264]: Connolly *et al.* (2012)
[265]: Ekici (2021)

outcomes. Motivational outcomes are also sometimes classified as a subcategory of affective outcomes [119], similar to the distinction in Bloom's taxonomy of educational objectives [266].

[119]: Dichev *et al.* (2017)

[266]: Bloom (1956)

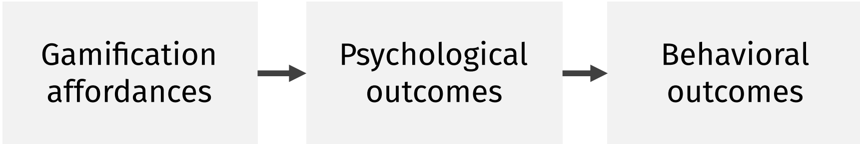


**Figure 3.7:** General conceptualization of gamification, based on [48].

### Psychological (Affective and Motivational) Outcomes

One of the reasons why gamification has become so popular is that gaming is considered as motivating [267]. Motivation explains the "why" of human behavior: it describes all internal processes giving behavior its energy and direction [268]. Motivation is a hypothetical construct that manifests in behavior and can lead to positive cognitive outcomes such as improved learning and achievement (e.g. [269]). Previous research largely supports a positive relationship between the use of serious games [264], [270] or gamification [110], [265] and motivational outcomes. However, some studies report contradictory results (e.g. [50], [271]–[273]). Beyond motivation, *affect* as a psycho-physiological construct includes the dimensions of valence, an evaluation of the subjectively experienced state, and arousal, a measure of activation that can be considered as a proxy for motivation [274]. Further affective outcomes of gamification that can be attributed to the valence dimension include satisfaction [275], [276] and positive attitudes towards the game [276] or the gamified subject [265], enjoyment [48], [277], immersion [264] and flow [48], [263].

[267]: Bai *et al.* (2020)

[268]: Reeve (1996)

[269]: Keller (2008)

[264]: Connolly *et al.* (2012)
[270]: Kordaki *et al.* (2017)

[110]: Sailer *et al.* (2020)
[265]: Ekici (2021)

[50]: Hamari *et al.* (2014)
[271]: Hanus *et al.* (2015)
[272]: Mekler *et al.* (2017)
[273]: Zimmerling *et al.* (2019)

[274]: Harmon-Jones *et al.* (2013)

[275]: Boyle *et al.* (2016)
[276]: Vlachopoulos *et al.* (2017)

[48]: Koivisto *et al.* (2019)
[277]: Ab Jalil *et al.* (2020)

[263]: Lamb *et al.* (2018)

### (Cognitive) Learning Outcomes

In addition, gamification contributes to a variety of learning outcomes [278], [279], most of which are cognitive in nature. Cognition can be understood as a set of processes and mechanisms by which an individual understands the world through reasoning and problem-solving [263], [280]. Studies report on significant improvements in critical thinking [237], creative thinking [237], [278], knowledge acquisition and content understanding [264], [276] and perceptual skills [263], [264], [276]. However, certain mixed results on learning outcomes suggest that only the combination with affective and motivational outcomes leads to cognitive learning outcomes that result in successful academic performance improvement [237], [267].

[278]: Behnamnia *et al.* (2020)
[279]: Gaalen *et al.* (2021)

[280]: Zimmerman *et al.* (2014)

[237]: Qian *et al.* (2016)

### Behavioral Outcomes

In diverse contexts like education [110], [264], [270], [281], employee training [282], software development [283], innovation [284] or energy conservation [54], motivating effects of gamification are consistently accompanied by positive behavioral outcomes. These include engagement and participation [119], [265], [281], social collaboration and teamwork [270], [276] and measurable performance improvements in academic and work tasks [48], [267]. Because of these positive effects, gamification is increasingly adopted in various use cases to promote behavioral change, for example towards physical activity (e.g. [68], [285]), knowledge transfer (e.g. [286], [287]) or engagement in PEB (e.g. [288], [289]).

[281]: Freitas *et al.* (2020)

[282]: Obaid *et al.* (2020)

[283]: Alhammad *et al.* (2020)

[284]: Patrício *et al.* (2018)

[54]: Johnson *et al.* (2017)

[68]: Dadaczynski *et al.* (2017)
[285]: Lier *et al.* (2019)

[286]: Holzer *et al.* (2020)
[287]: Mizuyama *et al.* (2019)

[288]: Du *et al.* (2020)
[289]: Ro *et al.* (2017)

Specifically, in the context of sustainable behaviors, research has explored gamification as a means to promote energy conservation in households (e. g. [53]–[55]). Furthermore, gamification is studied as a tool to promote sustainable travel and commuting (e. g. [56]–[58]), sustainable water management (e. g. [59]–[61]), eco-driving (e. g. [62]–[64]), eco-friendly nutrition (e.g. [65]) and recycling (e. g. [66], [67]).

[53]: Fraternali *et al.* (2019)
[54]: Johnson *et al.* (2017)
[55]: Morganti *et al.* (2017)

[56]: Andersson *et al.* (2018)
[57]: Lieberoth *et al.* (2018)
[58]: Ferron *et al.* (2019)

[59]: Aubert *et al.* (2019)
[60]: Novak *et al.* (2018)
[61]: Koroleva *et al.* (2020)

[62]: Massoud *et al.* (2019)
[63]: Nousias *et al.* (2019)
[64]: Günther *et al.* (2020)

[65]: Berger (2019)

[66]: Aguiar-Castillo *et al.* (2019)
[67]: González-Briones *et al.* (2019)

## 3.4 Theoretical Framework of this Research Project

Based on existing knowledge and theories in the interrelated fields of sustainability management, particularly sustainable employee behavior, green IS, and gamification, the following theoretical framework (Figure 3.8) guides the present DSR project and its evaluations explained in Chapter 2 at a theoretical level. As an extended version of the conceptualization of gamification put forward by Koivisto and Hamari [48], the theoretical framework encompasses the design of the gamified application, its adoption process, and the subsequent envisioned psychological, behavioral, and corporate outcomes. Accordingly, *understanding the research problem* (RQ1) as the first research objective of this research project is to analyze the design theories, gamification designs, psychological outcomes, behavioral outcomes, and corporate outcomes examined in previous related studies on gamification for sustainable employee behavior.

[48]: Koivisto *et al.* (2019)

Afterwards, the current research project draws on the perspective of *gamification research* as a lens for the design of the gamified application. In particular, existing knowledge on the *design of gamification* and related concepts (e.g., serious games, game-based learning, persuasive systems) is systematically reviewed from a *theoretical* (RQ2) and *empirical* (RQ3) perspective to support the design of the gamified application in the first DSR cycle. In designing the gamified application, the research project builds on the three general aspects of user experience in motivational IS [249], i.e., utilitarian aspects, hedonic aspects, and social aspects, to derive design suggestions from theory that satisfy all of these aspects important for successful gamification design. Since DSR, as presented in Chapter 2, is an iterative process of design refinement, the design of the gamified application is iteratively improved after each evaluation in light of these three aspects. Moreover, the first evaluation of the gamified application (RQ4), which focuses specifically on the *design of the artifact itself* in an artificial environment [103], is guided by these three aspects of user experience and contributes to previous research efforts on the successful design of gamification in the particular context of sustainable employee behavior at work.

[249]: Hamari *et al.* (2015)

[103]: Venable *et al.* (2016)

Subsequently, the *green IS perspective* with particularly extensive background research on the *adoption and use of green IS* in organizational contexts informs the evaluation of the gamified artifact in the second DSR cycle (RQ5), which focuses on *insights into employees' experiences of adopting and using the gamified application* [103]. Specifically, this research project builds on the DOI [214] as a procedural theory of IS adoption and activity theory [290] as a socio-technical theory of IS use [291] to examine the challenges of adopting and using the gamified system, contributing to previous research efforts on the challenges in adopting and using green IS.

[214]: Rogers (2003)

[290]: Engeström (2015)

[291]: Karanasios (2018)

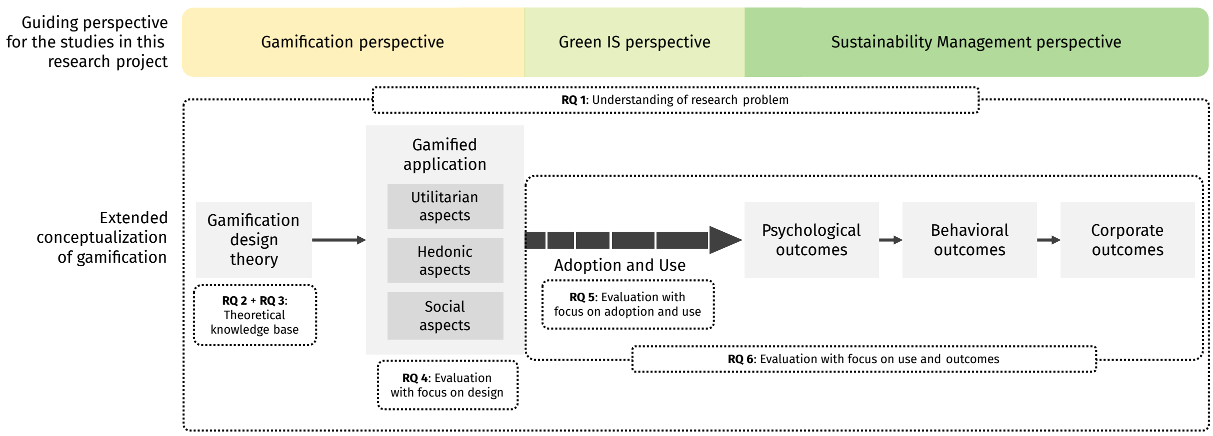


Figure 3.8: Theoretical framework of this research project based on an extended conceptualization of gamification [48] that benefits from the perspectives of research on gamification, green IS and sustainability management.

Finally, the *sustainability management perspective*, particularly theoretical considerations of *determinants of sustainable employee behavior*, guides the summative evaluation (RQ6) of the *effects of the gamified application* in the real-world environment [103]. Specifically, the TPB [166] and goal-framing theory [133] are used to examine psychological outcomes of the gamified application as determinants of behavioral outcomes that are hypothesized to contribute to corporate-level outcomes as well, consistent with the potentially significant impact of employee behavior on overall corporate sustainability [26], [27]. Through this evaluation, the research project contributes to previous research on sustainable employee behavior interventions from sustainability management research by examining the impact of gamification as a particular novel innovative solution for promoting sustainable employee behavior at work.

[103]: Venable *et al.* (2016)

[166]: Ajzen (1991)

[133]: Lindenberg *et al.* (2013)

[26]: Chen *et al.* (2015)
[27]: Paillé *et al.* (2014)

In summary, the research project, guided by the theoretical framework, contributes to the following research streams of previous research:

- *Design of gamification*, through a) synthesis of existing design knowledge (RQ2 + RQ3) and b) generation of new design knowledge for the specific context of workplace sustainability (RQ4)
- *Adoption and use of green IS*, by exploring the challenges of adopting the gamified application as a particular green IS from a procedural and socio-technical perspective (RQ5)
- *Effects and outcomes of gamification* as well as *interventions for sustainable employee behavior*, by examining the psychological, behavioral, and corporate outcomes of gamification as a novel intervention to motivate sustainable employee behavior at work (RQ6)

# Research Problem

# 4 Study 1: Systematic Review on Gamification for Sustainable Employee Behavior



## 4.1 Context and Aim of this Study

As stated in Chapter 2, the research problem identified in this thesis is the lack of applicable solutions to motivate various sustainable behaviors of employees at work that collectively add to the company's contribution to sustainable development. Although there is already considerable research effort on gamification as a means to promote sustainable behaviors related to specific aspects of sustainable development, such as employee health [68], [285], [292], [293] and energy conservation [80], [82], [84], [86], a systematic analysis of these previous research efforts is still missing.

[68]: Dadaczynski *et al.* (2017)
[285]: Lier *et al.* (2019)
[292]: Nagata *et al.* (2022)
[293]: Mamede *et al.* (2021)

[80]: Kotsopoulos *et al.* (2017)
[82]: Lou *et al.* (2019)
[84]: Oppong-Tawiah *et al.* (2020)
[86]: Iria *et al.* (2020)

However, a systematic search, analysis, and synthesis of previous studies that have used gamification to support sustainable behaviors in the workplace is imperative to gain a comprehensive understanding of the research problem and, in particular, the research gaps that this research project aims to address. In particular, consistent with the theoretical framework of this thesis (presented in Chapter 3), there is merit in examining the theoretical foundations, design, and outcomes of gamification at the psychological, behavioral, and corporate levels in order to derive recommendations for future research endeavors in this emerging field.

Therefore, this systematic review focuses on *collecting, analyzing, and aggregating the existing scientific knowledge on gamification for sustainable employee behavior at work*. Altogether, previous studies have examined more than 30 different theoretical foundations, 70 different utilitarian, hedonic, and social design elements, and more than 85 psychological, behavioral, and corporate outcomes. Following the analysis, research gaps are identified to derive 8 valuable agenda points for future research.

**Publication of this study.**

A preliminary version of this study has been presented at [97] J. Krath, S. Silva, and H. F. O. von Korflesch, "Gamification for sustainable employee behavior: a systematic review informed by goal-setting theory", presented at the 21st Annual Conference of the European Academy of Management (EURAM), [Online], Jun. 2021. However, for this thesis, the literature review was thoroughly updated, with adjustments to the search terms, search period, coding, analysis and discussion.

## 4.2 Theoretical Background

Consistent with the theoretical framework of this research project (see Chapter 3), previous research and theories guide the analytical procedure of this systematic review. Koivisto and Hamari [48] describe the general conceptualization of gamification in accordance with its definition as a process in which gameful affordances influence psychological outcomes that lead to intended behavioral outcomes.

[48]: Koivisto *et al.* (2019)
[249]: Hamari *et al.* (2015)

First, in terms of the gameful affordances, i.e. the design of gamification, Hamari et al. [249] distinguish between three aspects of user experience in motivational and gameful IS critical to the success of gamified systems: utilitarian, hedonic, and social. While utilitarian design elements are mostly intended to increase the usefulness [118] of the system in terms of behavior change [249], hedonic elements are intended to evoke enjoyment and fun [260] in behavior change [249], and social elements are intended to help promote social pressure and feelings of relatedness [261]. Thus, it

[118]: Davis (1989)

[260]: Heijden (2004)

[261]: Ryan *et al.* (2017)

is worth examining the ways in which previous studies of gamification for sustainable employee behavior have considered these three aspects of the user experience in their gamification design to discuss further design possibilities that could be explored in future research. Furthermore, previous research has called for a theory-driven rather than a purely exploratory approach to gamification design in order to best achieve the intended outcomes [111]. Against this background, the theoretical foundations of studies on gamification for sustainable employee behavior are analyzed to examine the state of theory-driven research in this area and to identify potential biases created by theoretical perspectives in the design and evaluation of gamification in this context.

[111]: Nacke *et al.* (2017)

Second, regarding psychological outcomes, goal-framing theory [133] and the TPB [166] have been used as theoretical foundations in research on sustainable employee behavior [136], [155], [168], [169] to explain the transition from affective and cognitive states elicited by interventions to the formation of behavioral intentions. The TPB is often used as a rational-choice theory of sustainable behavior [135] and posits that an individual's actual behavior depends on their behavioral intention, which is shaped by three determinants: behavioral attitude, subjective norm, and perceived behavioral control [166]. In turn, goal-framing theory [133] assumes that people's behavioral intentions are guided by three goal frames: gain goal frames, normative goal frames, and hedonic goal frames. Gain goal frames refer to people's self-interest, i.e., the perception that sustainable behavior is beneficial from a rational perspective, and include determinants such as attitude, subjective norm, and perceived behavioral control. Normative goal frames, on the other hand, refer to the belief that sustainable behavior is ”the right thing to do” [174], and hedonic goal frames describe the intention to feel good in the current moment and experience enjoyment from a particular behavior [133]. Together, these two theories provide a framework for examining the psychological ”pathway” to sustainable employee behavior that previous studies have focused on, specifically which goal frames have been most frequently targeted and in what ways this translates into behavioral intentions to change behavior.

[133]: Lindenberg *et al.* (2013)

[166]: Ajzen (1991)

[136]: Canto *et al.* (2023)
[155]: Unsworth *et al.* (2013)
[168]: Morren *et al.* (2016)
[169]: Katz *et al.* (2022)

[135]: Bamberg *et al.* (2007)

[174]: Steg *et al.* (2014)

Third, previous research has shown that individual employee behavioral changes can create changes at the corporate level and strongly influence the overall sustainability performance of the company. In this regard, it is therefore worthwhile to analyze both individual behaviors and corporate outcomes of gamification for sustainable employee behavior. The SDGs [12] provide a universally accepted framework to drive sustainable development in various dimensions, such as environment (e.g., SDG 6-7, SDG 11-15), social (e.g., SDG 1-5, SDG 10, SDG 16), and economic (e.g., SDG 8-9, SDG 17) ones. Accordingly, the SDGs serve as a theoretical framework to examine which dimensions of sustainable employee behavior (and outcomes) previous studies in this area have focused on and in which dimensions there may be room for future research efforts.

[12]: United Nations (2020)

Conclusively, the theoretical model derived from previous research and theoretical foundations in the fields of gamification and sustainable employee behavior presented in Figure 4.1[3] guides the analysis and discussion

[3] SDG icons taken from `https://www.un.org/sustainabledevelopment/`). The content of this publication has not been approved by the United Nations and does not reflect the views of the United Nations or its officials or Member States.

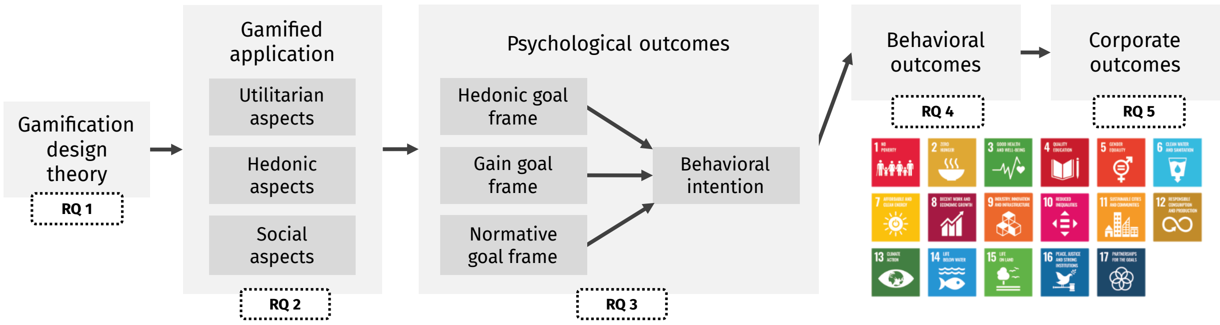


**Figure 4.1:** Theoretical model for the systematic review on gamification for sustainable employee behavior.

of this systematic review on previous studies related to gamification for sustainable employee behavior.

## 4.3 Research Method

The systematic literature review presents a narrative review of the existing literature in the area of gamification and gameful systems to support, motivate, or encourage sustainable employee behavior. Generally, narrative reviews focus on theories, factors, and outcomes of previous research to guide future research in a field, often building on a previously established model [105]. Because narrative reviews have been criticized for often being opportunistic and lacking an explanation of the review process [105], [106], I decided to use a transparent, comprehensive search strategy similar to a scoping review to collect all relevant studies in the field, with explicit study selection and quality assessment [106], to ensure the reliability of the subsequent narrative and concept-centered [104] review guided by the theoretical model (Figure 4.1). Consistent with the theoretical model, the following research questions will be answered by coding and analyzing existing studies on gamification for sustainable employee behavior:

[105]: King *et al.* (2005)
[106]: Paré *et al.* (2015)

[104]: Webster *et al.* (2002)

**RQ 1:** *Which theories have been employed in studies on gamification for sustainable employee behavior?*

**RQ 2:** *Which game design elements have been used in studies on gamification for sustainable employee behavior?*

**RQ 3:** *Which psychological outcomes have been identified in studies on gamification for sustainable employee behavior?*

**RQ 4:** *Which behavioral outcomes have been identified in studies on gamification for sustainable employee behavior?*

**RQ 5:** *Which corporate outcomes have been identified in studies on gamification for sustainable employee behavior?*

**Search strategy.** The ROSES [107] guideline provided detailed instructions on each step of the screening and selection process. Scopus database was used as the primary source for searching relevant literature as it provides the most comprehensive indexing of journal publishers and conference proceedings in the field of management and computer science, including, for example, Elsevier, Wiley Online, SAGE Pub, IEEE, ACM, and the AIS Library [4]. To include as many relevant findings as possible, I used the broader term "gamif*," which includes verbs such as "gamified," to include studies that relate to game-based learning or serious games. In addition, drawing from the methodological recommendations of the AURORA-SDG queries [294] and Elsevier's Scopus queries [295], a number of terms related to all 17 SDGs were added to include all relevant research related to sustainability. Finally, several terms related to the corporate work environment, such as "employee*", "workplace", or "job*", were used to search for relevant articles specifically addressing sustainable employee behavior.

[107]: Haddaway *et al.* (2018)

[294]: Jayabalasingham *et al.* (2019)

[295]: Schmidt *et al.* (2021)

The term "work*" was not included because it resulted in a large number of irrelevant studies in a previous pilot search that referred to "their work" in the abstracts. In addition, "compan*" was not included because it led to a large number of studies that referred to gamification in marketing and social media (in combination with the term "social" from the SDG-related terms), but no relevant additions related to gamification for sustainable employee behavior. Therefore, the search was conducted in January 2023 using the following search term:

**Search string:** *TITLE-ABS-KEY ("gamif*" AND (("manag*" OR "employ*" OR "workplace" OR "HR" OR "human resource" OR "human resources" OR "job*") AND ("health" OR "well-being" OR "innovation" OR "gender" OR "water" OR "resilience" OR "sustainab*" OR "environ*" OR "green" OR "ecolog*" OR "energy" OR "social" OR "societ*" OR "consum*" OR "inclusi*" OR "equality" OR "climate" OR "justice" OR "poverty" OR "hunger" OR "crime" OR "nutrition" OR "growth" OR "infrastructure" OR "city" OR "cities" OR "transport" OR "marine" OR "pollution" OR "ocean" OR "sea" OR "terrestrial" OR "land" OR "biodivers*" OR "ecosystem*" OR "deforest*" OR "conflict" OR "peace")))*

**Screening strategy and inclusion criteria.** Following the ROSES standard [107], screening was carried out in three steps: Title Screening, abstract screening and full text screening. To ensure the quality of the research, only studies from peer-reviewed journal articles and peer-reviewed conference papers were included in the final sample. Conference papers were considered important because they account for a significant proportion of citations in computer science and human-computer interaction research [296] and because the identification of studies from conference proceedings in systematic reviews is generally accepted as good practice [297]. As a language criterion, only English-language articles were included. Further, since the review focuses on the theories, game design elements and outcomes used and investigated in previous studies, only empirical articles (both qualitative and quantitative) were included, whereas review

[107]: Haddaway *et al.* (2018)

[296]: Michels *et al.* (2014)

[297]: Scherer *et al.* (2019)

[4] Scopus access for the University of Koblenz was introduced in January 2023. Unlike Chapter 6 and Chapter 5, in which publishers' libraries were searched individually, Scopus was therefore used for the update of this review in January 2023 as a comprehensive umbrella database indexing all relevant publishers' libraries.

Table 4.1: Inclusion and exclusion criteria for the review on gamification for sustainable employee behavior.

| Criterion | Included | Excluded |
|---|---|---|
| Language | English | Other languages, e.g. Spanish, German, Russian, Korean, Chinese, Japanese |
| Publication type | Peer-reviewed journals, peer-reviewed conference papers | Book chapters, magazine articles, reports, theses, other grey literature |
| Type of study | Empirical studies | Conceptual studies, systematic reviews, editorial articles |
| Study topic | Gamification, serious games, game-based learning | Video games, gamification only mentioned in outlook or discussion |
| Study context | Workplace | Schools, private households |
| Study goal | Sustainability (in relation to the SDGs) | Marketing, service, productivity, optimization |

articles, conceptual articles and editorial articles were excluded. In addition, studies that were either not related to any of the SDGs (e.g., studies that referred to "organizational climate", "organizational environment" or "gamified environment") or the workplace context (e.g., studies in schools or private households or studies related to individual health treatments, such as diabetes treatment) were excluded. Finally, studies that did not primarily deal with gamification, but only mentioned gamification and gamified approaches in the outlook or discussion, were excluded.

The inclusion and exclusion criteria for the article screening are summarized in Table 4.1.

**Critical appraisal strategy.** For the critical assessment of the quality of the reviewed articles, the following criteria were checked for each individual study:

1. Did the authors formulate at least one clear research question or research goal?
2. Did the authors describe their research method?
3. Did the authors answer their research question(s)/goal(s) properly?

Figure 4.2 illustrates the result of the search strategy and screening process. A total of 56 articles remained for data extraction and synthesis. For reproducibility, the entire list of excluded full texts is attached in Section A.1.

**Data extraction strategy.** Metadata such as title, year of publication, authors, publication type (journal or conference proceedings), and publication name of the articles were extracted using Mendeley Reference Manager and manually checked during import. Following the guidelines of Webster and Watson [104], author-centered qualitative data extraction coded the topic, associated SDG, and methodological approach of the study, as well as the understanding of gamification (gamification, serious game, or other). Furthermore, the theories employed, the utilitarian, hedonic, and social design elements used in the study, and the psychological, behavioral, and corporate outcomes were coded inductively, with the latter noted as one of the following categories to account for the significance of the results: Positive (significant), positive (descriptive), positive (qualitative), no effect (descriptive), no effect (qualitative), mixed (significant), mixed (descriptive), mixed (qualitative), negative (significant), negative (descriptive), and negative (qualitative). In the subsequent concept-centered phase, the coded results were analyzed and organized into frequency matrices, guided by

[104]: Webster *et al.* (2002)

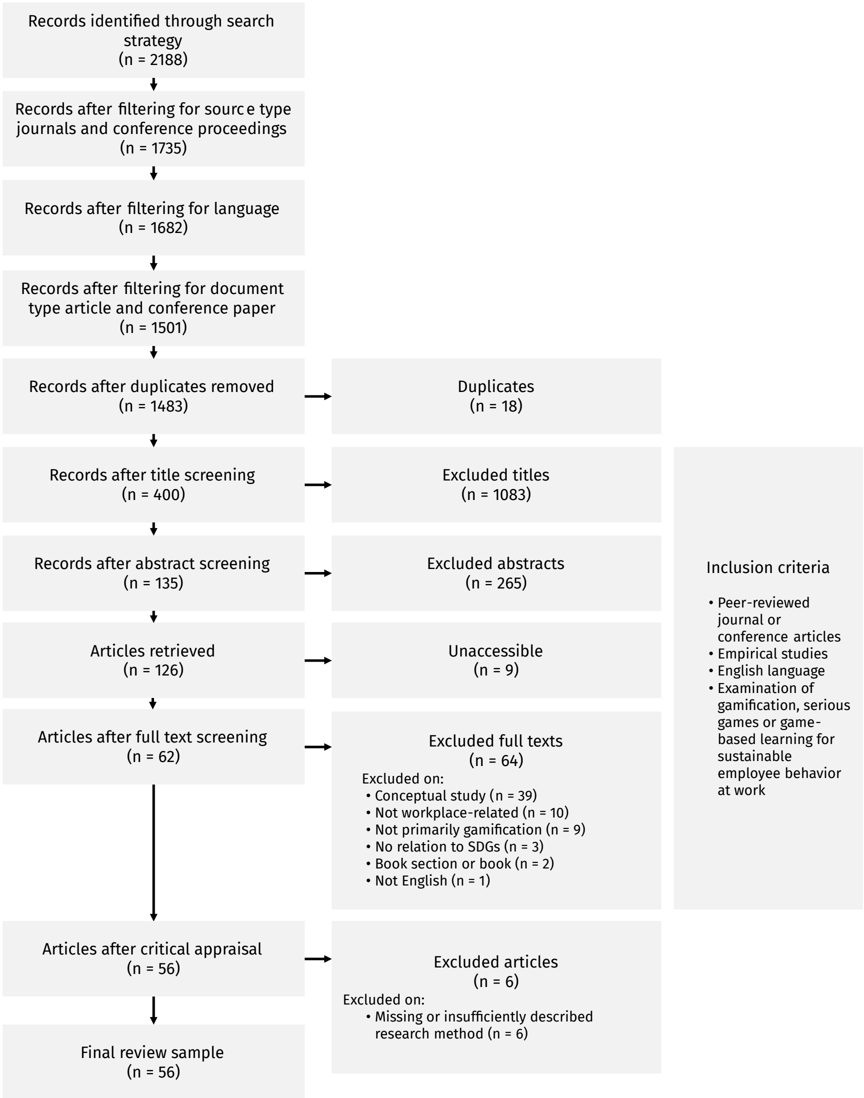


**Figure 4.2:** Flow diagram for the selection of studies in the systematic review on gamification for sustainable employee behavior.

the theoretical model presented in the background section (Figure 4.1), i.e. the general aspects of user experience [249], goal-framing theory [133], the TPB [166] and the SDGs.

[249]: Hamari *et al.* (2015)

[133]: Lindenberg *et al.* (2013)

[166]: Ajzen (1991)

## 4.4 Results

In the analysis, I first narratively report on the quality of the reviewed sample, the research topics, and the methods of the articles studied, followed by the qualitative analysis of employed theories (**RQ1**), game design elements (**RQ2**), psychological outcomes (**RQ3**), behavioral outcomes (**RQ4**) and corporate outcomes (**RQ5**).

### 4.4.1 Sample Quality, Research Topics, and Methods

Critically assessing the quality of the sample, it can be noted that most of the included articles were published in peer-reviewed journals, most of which are ranked highly in Scientific Journal Ranking (SJR) and Journal

Impact Factor (JIF). 20 of the 36 journal articles were published in the first quartile and 3 of the 36 articles were published in the second quartile of their respective research fields, mainly in health informatics, health, business informatics, management, and human-computer interaction. Most conferences were not graded in the rankings considered, despite the very prestigious Hawaii International Conference on System Sciences. This may be due to the specialization of some conferences in narrow topics such as pervasive technologies, technologies for sustainability, or health informatics, but is not necessarily indicative of low study quality. Since only peer-reviewed conference papers were included in the final sample, a scientific assessment of the quality of the articles is certainly warranted.

The first two empirical studies on gamification for sustainable employee behavior were published in 2014 (see Figure 4.3). They primarily addressed how gamification can be used ethically in work environments to support and not disrupt employee well-being [298] and how gamification can support impaired workers in industrial settings [299]. In 2015 and 2016, the topics of gamification to reduce inequalities, e.g., in assessing the abilities of impaired job applicants [300], and to support workplace well-being [301], gained traction, but it was not until 2017 that interest in gamification as a tool to promote environmental sustainability in organizations, e.g., to promote energy conservation among employees [78], [80], [83], increased. In the same vein, research studies on gamification to promote physical activity and thus physical health among employees also emerged (e.g. [68], [69]). In 2018, gamification research streams arose at a larger enterprise level, e.g., to support innovation processes [302] and sustainability in supply chain management [88]. The years 2019-2020 were marked by an increasing number of studies in the field of energy conservation [79], [81], [82], [84]–[86], well-being and quality of care in health care [303]–[308] and ideation and open innovation [75], [309], [310]. It is noteworthy that recently, interest in gamification for environmentally friendly behaviors has declined, while gamification for physical [292], [293], [311], [312] and mental health [70]–[73] of employees has regained traction, accompanied by a steady interest in gamification as a tool for innovation and value creation [76], [77], [313].

Furthermore, individual studies have explored how gamification could support sustainable commuting [87] and emergency management [314], as well as the goal of justice as a means to promote cybersecurity awareness [315], [316] and improve law enforcement by police officers [317]. Finally, the topic of responsible consumption and production, while naturally included to some extent in energy conservation studies, has not yet received much attention, with single empirical studies on waste reduction and recycling [89] and eco-friendly food choices [318] at work.

In summary, there is a large dominance of research on gamification for health and well-being at work, accompanied by a medium level of interest in gamification for innovation and energy conservation, while most of the 17 SDGs remain unexplored as dimensions of sustainable behavior that could be motivated by gamification at work.

Regarding the understanding of gamification, about half of the articles describe gamified applications, either for mobile phones (13 articles) or web browsers (8 articles), or gamification mechanisms integrated into existing enterprise systems (5 articles). On the other hand, fourteen articles discuss serious games, for example, in the form of digital games (5 articles), simulations (2 articles), board games (3 articles), card games (3 articles),

[298]: Shahri *et al.* (2014)
[299]: Korn *et al.* (2014)
[300]: Korn *et al.* (2016)
[301]: Jent *et al.* (2016)
[78]: Hafer *et al.* (2017)
[80]: Kotsopoulos *et al.* (2017)
[83]: Lounis *et al.* (2017)
[68]: Dadaczynski *et al.* (2017)
[69]: Kouwenhoven-Pasmooij *et al.* (2017)
[302]: Janocha *et al.* (2018)
[88]: Putz *et al.* (2018)
[79]: Kaselofsky *et al.* (2020)
[81]: Kotsopoulos *et al.* (2020)
[82]: Lou *et al.* (2019)
[84]: Oppong-Tawiah *et al.* (2020)
[85]: Stroud *et al.* (2020)
[86]: Iria *et al.* (2020)
[303]: Lowensteyn *et al.* (2019)
[304]: Newcomb *et al.* (2019)
[305]: Brown *et al.* (2020)
[306]: Jackson *et al.* (2020)
[307]: Nguyen *et al.* (2020)
[308]: Tuti *et al.* (2020)
[75]: Patricio *et al.* (2020)
[309]: Nivedhitha *et al.* (2020)
[310]: Viberg *et al.* (2020)
[292]: Nagata *et al.* (2022)
[293]: Mamede *et al.* (2021)
[311]: Nuijten *et al.* (2022)
[312]: Zhang *et al.* (2021)
[70]: Hungerbuehler *et al.* (2021)
[71]: Ladakis *et al.* (2021)
[72]: Waddell *et al.* (2021)
[73]: Cheng *et al.* (2022)
[76]: Patrício *et al.* (2021)
[77]: Patricio *et al.* (2022)
[313]: Colabi *et al.* (2022)
[87]: Wunsch *et al.* (2016)
[314]: Heldal (2016)
[315]: Hart *et al.* (2020)
[316]: Omiya *et al.* (2019)
[317]: Raflesia *et al.* (2022)
[89]: Respati *et al.* (2018)
[318]: Huber *et al.* (2015)

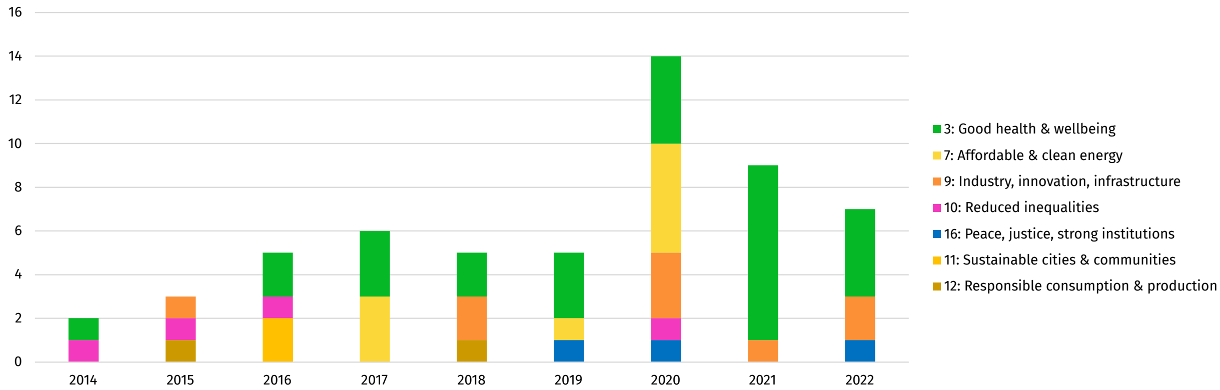


Figure 4.3: Distribution of topics of studies on gamification for sustainable employee behavior over the years.

Table 4.2: Research topics of the reviewed articles.

| Research topic | No. | Articles |
|---|---|---|
| **SDG 3: Good health and well-being** | **27** | |
| Physical activity at work | 8 | [68], [69], [285], [292], [293], [311], [319], [320] |
| Well-being at work | 5 | [298], [303], [305], [321], [322] |
| Improvement of care work | 3 | [304], [323], [324] |
| Reporting of consequences after vaccination | 1 | [307] |
| Employee sleep | 1 | [72] |
| Stress coping and teamwork at work | 1 | [73] |
| Prevention of pandemic risks in healthcare | 1 | [325] |
| Healthy lifestyle at work | 1 | [312] |
| Resilience in healthcare sector | 1 | [306] |
| Well-being of flexible/self-employed workers | 1 | [301] |
| Technostress at work | 1 | [326] |
| Employee mental health | 1 | [70] |
| Stress at work | 1 | [71] |
| Medical emergency reactions in care | 1 | [308] |
| **SDG 9: Industry, innovation and infrastructure** | **9** | |
| Innovation in companies | 3 | [76], [77], [302] |
| Creative ideation in companies | 2 | [74], [309] |
| Open innovation and value co-creation | 2 | [75], [313] |
| Sustainable supply chain management | 1 | [88] |
| Ideation and knowledge sharing in companies | 1 | [310] |
| **SDG 7: Affordable and clean energy** | **9** | |
| Energy conservation at work | 9 | [78]–[86] |
| **SDG 10: Reduced inequalities** | **4** | |
| Assistance for impaired employees | 2 | [299], [327] |
| Skill assessment of impaired applicants | 1 | [300] |
| Intergenerational knowledge transfer | 1 | [328] |
| **SDG 16: Peace, justice and strong institutions** | **3** | |
| Cybersecurity in organizations | 2 | [315], [316] |
| Law enforcement by police employees | 1 | [317] |
| **SDG 11: Sustainable cities and communities** | **2** | |
| Sustainable commuting | 1 | [87] |
| Emergency/disaster management | 1 | [314] |
| **SDG 12: Responsible consumption and production** | **2** | |
| Waste reduction and recycling at work | 1 | [89] |
| Eco-friendly food choice in canteens | 1 | [318] |

and Virtual Reality (VR) games (1 article). In addition, six articles describe gamified campaigns or general corporate challenges without a specific system, and three articles present workshops that included gamified practices or serious games. Finally, two articles refer to an augmented workspace through gamification, one article describes a stationary gamified interface in the coffee kitchen, and four (design-oriented) articles don't specify their understanding of gamification.

In terms of research methods, the majority of studies use quantitative methods to examine the effects and outcomes of gamification for sustainable employee behavior. These methods include quantitative field experiments, either controlled (6 articles) or without control group (17 articles), quantitative laboratory experiments, either controlled (3 articles) or without control group (3 articles), and quantitative surveys (7 articles). In addition, eleven studies use mixed methods, including mixed-method field experiments (6 articles), mixed-method controlled experiments (1 article), mixed-method design studies (2 articles), as well as mixed-method expert studies (1 article) and mixed-method case studies (1 article). Finally, nine articles use qualitative research methods, such as exploratory case studies (6 articles), qualitative interviews (2 articles), and field observation (1 article).

### 4.4.2 Theoretical Foundations

With respect to the theories used to design and study gamification for sustainable employee behavior (**RQ1**), it is noteworthy that the majority (33 of 56) of the studies do not invoke any theory or framework for their study (see Table 4.3). Beyond that, the studies analyzed use a variety of 34 different theoretical frameworks, with most theories being used in only one study.

Of the theories used as the basis for empirical studies, SDT, a theory of motivation (which includes cognitive evaluation theory [337] and organismic integration theory [347]) that focuses on the basic psychological needs of autonomy, competence, and relatedness, the role of extrinsic incentives, and the processes of introjection for intrinsic motivation ([261]), is most commonly used to guide the design of gamified artifacts that address the three basic needs (e.g. [81], [322], [323]) and various forms of intrinsic as well as extrinsic motivation [84], [311], [323]. In addition, studies draw on the TPB, which describes individual attitudes, social norms, and perceived behavioral control as antecedents of behavioral intention and behavior [166], and its predecessor, the TRA [164], to guide the design [82], [305], [311] and evaluation [68], [88] of gamified applications.

In general, theories are used to design rather than evaluate gamification for sustainable employee behavior. From social psychology, social cognitive theory [329] is used to explain the intended social learning effects of social gamification elements [309] and, similar to goal setting theory [358] motivate design elements that promote self-efficacy (a concept also first described by Bandura [352] and then integrated into social learning theory [359] to form social cognitive theory) [68] [293], [311], [320]. In addition, studies rely on gamification design frameworks, such as Werbach and Hunter's 6D framework [227] and the Meaningful Gamification Framework [345], to design their gamified intervention.

[337]: Deci *et al.* (1985)

[347]: Deci *et al.* (1985)

[261]: Ryan *et al.* (2017)

[81]: Kotsopoulos *et al.* (2020)
[322]: Shahrestani *et al.* (2017)
[323]: McKeown *et al.* (2016)

[84]: Oppong-Tawiah *et al.* (2020)
[311]: Nuijten *et al.* (2022)
[323]: McKeown *et al.* (2016)

[166]: Ajzen (1991)

[164]: Ajzen *et al.* (1980)

[82]: Lou *et al.* (2019)
[305]: Brown *et al.* (2020)
[311]: Nuijten *et al.* (2022)

[68]: Dadaczynski *et al.* (2017)
[88]: Putz *et al.* (2018)

[329]: Bandura (2001)

[309]: Nivedhitha *et al.* (2020)

[358]: Locke *et al.* (2013)

[352]: Bandura (1982)

[359]: Bandura (1978)

[293]: Mamede *et al.* (2021)

[320]: Gremaud *et al.* (2018)

[227]: Werbach *et al.* (2012)

[345]: Nicholson (2012)

Table 4.3: Theories used in the reviewed articles.

| Theory | Origin | No. | Articles |
|---|---|---|---|
| Self-determination theory | [261] | 5 | [80], [84], [311], [322], [323] |
| Theory of planned behavior | [166] | 5 | [68], [82], [88], [305], [311] |
| Social cognitive theory | [329] | 4 | [68], [293], [309], [320] |
| 6D framework | [227] | 3 | [75]–[77] |
| Flow theory | [330] | 3 | [299], [309], [311] |
| Fogg's behavior model | [239] | 2 | [84], [311] |
| Goal-setting theory | [331] | 2 | [311], [320] |
| Human activity assistive technology model | [332] | 2 | [299], [327] |
| Technology acceptance model | [118] | 2 | [88], [315] |
| Transtheoretical model of behavior change | [333] | 2 | [292], [312] |
| ADDIE model | [334] | 1 | [316] |
| ARCS model | [117] | 1 | [316] |
| Broaden-and-build theory | [335] | 1 | [309] |
| Capability, opportunity and motivation framework | [336] | 1 | [311] |
| Cognitive evaluation theory | [337] | 1 | [320] |
| Constructivist learning theory | [338], [339] | 1 | [315] |
| Habituation theory | [340] | 1 | [84] |
| Health action process approach | [341] | 1 | [68] |
| Health belief model | [342] | 1 | [305] |
| Job characteristics model | [343] | 1 | [84] |
| Know-check-move paradigm | [344] | 1 | [322] |
| Meaningful gamification framework | [345] | 1 | [325] |
| Four drives theory | [346] | 1 | [81] |
| Organismic integration theory | [347] | 1 | [321] |
| Plan, do, study, act model | [348] | 1 | [305] |
| Player type theory (Hexad and Bartle) | [349], [350] | 1 | [81] |
| Risk-taking theory | [351] | 1 | [320] |
| Self-efficacy theory | [352] | 1 | [311] |
| Self-regulatory model | [353] | 1 | [305] |
| SERES framework | [354] | 1 | [325] |
| Theory of network externalities | [355] | 1 | [309] |
| Theory of reasoned action | [164] | 1 | [88] |
| Transactional stress model | [356] | 1 | [309] |
| Vygotsky's theory of creativity | [357] | 1 | [309] |

Clustering the theories used in line with previous categorizations of the objectives of gamification and game-based learning (motivation and affect, behavior and learning, see Table 4.4) [258], [266], it becomes evident that most of the theoretical foundations in studies on gamification for sustainable employee behavior are theories related to affect and motivation, followed by a significant number of behavioral theories, while learning theories are less used. In addition, nearly one-fifth of all studies rely on design frameworks or models to guide the design of gamification.

[258]: Plass *et al.* (2015)
[266]: Bloom (1956)

### 4.4.3 Gamification Design

In terms of gamification design (**RQ2**), previous studies have used various utilitarian, hedonic, and social design elements, often in complementary ways, to elicit positive psychological experiences and lead to intended behavioral outcomes. Although it can often be difficult to distinguish which design elements are utilitarian and hedonic, as such affordances can serve multiple purposes and may be perceived as utilitarian by some users and

Table 4.4: Clustered theories used in the reviewed articles.

| Cluster | No. | % | Articles |
|---|---|---|---|
| **Theories related to affect and motivation**<br>Self-determination theory<br>Flow theory<br>Goal-setting theory<br>ARCS model<br>Cognitive evaluation theory<br>Four drives theory<br>Organismic integration theory<br>Self-efficacy theory<br>Health action process approach<br>Self-regulatory model<br>Transactional stress model<br>Player type theory (Hexad and Bartle)<br>Job characteristics model<br>Broaden-and-build theory | 13 | 23.2% | [68], [80], [81], [84], [299], [305], [309], [311], [316], [320]–[323] |
| **Theories related to behavior**<br>Theory of planned behavior<br>Fogg's behavior model<br>Technology acceptance model<br>Transtheoretical model of behavior change<br>Habituation theory<br>Theory of reasoned action<br>Health belief model<br>Risk-taking theory | 11 | 19.6% | [68], [82], [84], [88], [292], [305], [311], [312], [315], [320], [360] |
| **Theories related to learning**<br>Social cognitive theory<br>Constructivist learning theory | 5 | 8.9% | [68], [293], [309], [315], [320] |
| **Design theories and frameworks**<br>6D framework<br>ADDIE model<br>Meaningful gamification framework<br>SERES framework<br>Plan, do, study, act model<br>Human activity assistive technology model<br>Capability, opportunity and motivation framework<br>Know-check-move paradigm | 10 | 17.9% | [75]–[77], [299], [305], [311], [316], [322], [325], [327] |
| **Other theories**<br>Theory of network externalities<br>Vygotsky's theory of creativity | 2 | 3.6% | [81], [309] |

[361]: Köse *et al.* (2019)

hedonic by others [361], the present categorization portrays typical game elements such as points and badges as primarily hedonic, while utilitarian elements include design elements that are not directly tied to gameful experiences, such as informational content.

### Utilitarian Elements

Among the utilitarian elements, studies primarily used informational content, sensor tracking, and direct feedback to support users in changing their behavior toward desired goals (see Table 4.5).

[303]: Lowensteyn *et al.* (2019)

[285]: Lier *et al.* (2019)

*Informational content* comes in many forms, such as instructional videos for healthy lifestyles [303] and workouts [285] or detailed text-based mental

Table 4.5: Utilitarian design elements used in the reviewed articles.

| Cluster | No. | Articles |
|---|---|---|
| Informational content | 15 | [68]–[70], [81], [89], [285], [301], [303]–[306], [308], [315], [322], [323] |
| Sensor tracking | 13 | [69], [71], [72], [81], [82], [84], [86], [285], [293], [301], [303], [311], [322] |
| Direct feedback | 11 | [70], [75]–[77], [88], [306], [308], [315], [316], [324], [325] |
| Goal setting | 9 | [68], [69], [72], [73], [293], [301], [303], [311], [312] |
| Summary dashboard | 9 | [78], [82], [86], [293], [305], [310], [312], [317], [320] |
| Tips | 7 | [68], [79], [81], [82], [84], [86], [301] |
| Newsletter with data | 6 | [79], [89], [292], [293], [323], [324] |
| Posters and stickers | 6 | [79], [89], [292], [293], [304], [323] |
| Reminders | 6 | [68], [84], [86], [305], [320], [323] |
| Feedback graphs | 6 | [86], [292], [293], [303], [305], [320] |
| Assessment questionnaire | 5 | [70], [303], [307], [311], [326] |
| Instruction | 5 | [71], [299], [304], [316], [327] |
| Suggestive questions | 4 | [75]–[77], [315] |
| Instructional workshop | 4 | [69], [73], [88], [303] |
| Action planning | 4 | [68], [69], [73], [77] |
| Game coach | 3 | [69], [77], [312] |
| Manual activity tracking | 3 | [87], [293], [311] |
| Individual coaching session | 2 | [69], [303] |
| System tracking | 1 | [328] |
| Idea submission | 1 | [310] |
| Tasks | 1 | [317] |
| Checklist | 1 | [79] |
| Explanation of actions | 1 | [316] |
| Self-evaluation | 1 | [68] |
| Diary of activities | 1 | [319] |
| Scheduling | 1 | [78] |
| Map | 1 | [320] |

health information provided on demand [70]. In addition, serious games provide informational content in the form of text-based information about the relevance of the context and behaviors in the simulation [306], [308].

Informational content and *direct feedback* are often intertwined. For example, in serious games with primarily educational purposes, information is also conveyed in the form of direct feedback messages with explanations about whether a choice made in the game was right or wrong [306], [308], [315], [316], [324], [325]. On the other hand, direct feedback can also take the form of verbal feedback in gamified workshops [75]–[77], [88].

In this context, *tips* also represent a special form of informational content. In the form of information "nuggets", tips convey small bits of information and are particularly used in mobile applications to save energy [79], [81], [82], [84], [86] as they often rely on push notifications to employees' devices.

*Sensor tracking* is a utilitarian element that is often used to automate the input of user behavior into the gamified system. In the context of employee health, fitness trackers such as Fitbit are used in studies to automatically monitor employee physical activity [69], [72], [285], [293], [303], [311], [320]. On the other hand, smart plugs and sensors that measure the energy consumption of electronic devices are used to capture the energy saving behavior of employees [81], [82], [84], [86]. Other sensors that have been

[70]: Hungerbuehler *et al.* (2021)

[306]: Jackson *et al.* (2020)
[308]: Tuti *et al.* (2020)

[315]: Hart *et al.* (2020)
[316]: Omiya *et al.* (2019)
[324]: Strong *et al.* (2021)
[325]: Suppan *et al.* (2021)

[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[77]: Patricio *et al.* (2022)
[88]: Putz *et al.* (2018)

[79]: Kaselofsky *et al.* (2020)
[81]: Kotsopoulos *et al.* (2020)
[82]: Lou *et al.* (2019)
[84]: Oppong-Tawiah *et al.* (2020)
[86]: Iria *et al.* (2020)

[69]: Kouwenhoven-Pasmooij *et al.* (2017)
[72]: Waddell *et al.* (2021)
[285]: Lier *et al.* (2019)
[293]: Mamede *et al.* (2021)
[303]: Lowensteyn *et al.* (2019)
[311]: Nuijten *et al.* (2022)
[320]: Gremaud *et al.* (2018)

used in the studies analyzed include sleep sensors [72] and stress sensors that measure arousal in stress reduction applications [71]. In one particular study, a different form of tracking was used in which knowledge sharing activities in a knowledge management system to promote intergenerational knowledge transfer were automatically *tracked within the system* rather than by an external sensor [328]. In other cases where sensors are not present, employees are asked to m*anually track their activities* as input to the gamified application. For example, some studies use manual input for recording physical activities [293], [311] or cycling routes [87], while others ask users to maintain a *diary of physical activities* [319].

[72]: Waddell *et al.* (2021)
[71]: Ladakis *et al.* (2021)
[328]: Pfeiffer *et al.* (2020)
[293]: Mamede *et al.* (2021)
[311]: Nuijten *et al.* (2022)
[87]: Wunsch *et al.* (2016)
[319]: Barna *et al.* (2018)

*Goal setting* is a particular element used in studies to individualize behavioral goals (as opposed to, for example, challenges, which are defined uniformly for all employees). It is most commonly used for physical activity [68], [293], [301] and healthy lifestyle [311], and in some cases accompanied by professional guidance from a physician or therapist [69], [312]. In other studies, *assessment questionnaires* are used to set goals at the beginning of the intervention and track progress over time, assessing employee health [70], [303], current physical activity [311], or level of technostress [326].

[68]: Dadaczynski *et al.* (2017)
[301]: Jent *et al.* (2016)
[69]: Kouwenhoven-Pasmooij *et al.* (2017)
[312]: Zhang *et al.* (2021)
[70]: Hungerbuehler *et al.* (2021)
[303]: Lowensteyn *et al.* (2019)
[326]: Pasini *et al.* (2022)

In order to accomplish goals, studies employ elements of *action planning*, i.e., which activities to perform and in what order. For example, participants in gamified workshops collaborate on plans for future workplace stress management [73] and implementation of developed innovation ideas [326]. In this context, the utilitarian element of *scheduling* (i.e., determining when to automatically turn off electronic devices) is also used to help employees save energy [78]. In addition, gamified applications are accompanied by instructional features, instructional workshops, and individual coaching sessions. *Instructional workshops* and *coaching sessions* take place outside the application (e.g. in the form of educational group sessions [69] or individual counseling sessions with a health behavior change specialist [303]), while *instructional modules* that tell employees what to do next are included in serious games [71], [316] or augmented workplaces [299], [327]. Predefined *checklists* [79] or *tasks* [317] represent another form of goal guidance used in the analyzed studies. Especially in gamified workshops, *suggestive questions* [75]–[77], [315] (in the form of "How would you decide?") by cards or *game coaches* [77] are another way to define actions to meet goals in specific situations, e.g., to defend against cybersecurity attacks [315]. Sometimes, participants may subsequently need to *explain their choices* to their group members to convince them that their decision is the right way to achieve the goal [316].

[73]: Cheng *et al.* (2022)
[78]: Hafer *et al.* (2017)
[316]: Omiya *et al.* (2019)
[299]: Korn *et al.* (2014)
[327]: Korn *et al.* (2015)
[79]: Kaselofsky *et al.* (2020)
[317]: Raflesia *et al.* (2022)
[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[77]: Patricio *et al.* (2022)
[315]: Hart *et al.* (2020)

For monitoring users' progress toward their goals, studies use summary dashboards and feedback graphs. *Summary dashboards* primarily aggregate employee performance, such as how much energy (in kWh) they saved [78], [82], [86] or how many steps they took [293], [320]. *Feedback graphs* resemble summary dashboards (and in most cases are displayed on these dashboards), but some studies also employ standalone feedback graphs, e.g., in the form of a spiderweb graph of performance on various health-related dimensions [292] or the display of Fitbit data [303].

[82]: Lou *et al.* (2019)
[86]: Iria *et al.* (2020)
[320]: Gremaud *et al.* (2018)
[292]: Nagata *et al.* (2022)

*Email newsletters* with information about achievements are another means of monitoring progress, but unlike summary dashboards or feedback graphs, newsletters are typically sent outside the gamified system. For example, studies have used newsletters to inform participants about what has generally been achieved by all participants [79], [89], [323].

[79]: Kaselofsky *et al.* (2020)
[89]: Respati *et al.* (2018)
[323]: McKeown *et al.* (2016)

Finally, to increase topic awareness and ongoing engagement in behavior change, studies employ posters and stickers in the workplace, as well as reminders. *Posters* are most commonly used in gamified campaigns, whether for energy conservation [79], care work [323], [304], physical activity [292], or waste reduction [89]. On the other hand, *reminders* not intended to be informative (such as tips) but to be small "nudges" to behave or interact with the application are mostly used in gamification apps (either for smartphones [84] or web apps [68], [86], [305], [320]) in the form of push notifications.

[304]: Newcomb *et al.* (2019)
[292]: Nagata *et al.* (2022)
[84]: Oppong-Tawiah *et al.* (2020)
[68]: Dadaczynski *et al.* (2017)
[86]: Iria *et al.* (2020)
[305]: Brown *et al.* (2020)
[320]: Gremaud *et al.* (2018)

### Hedonic Elements

Among hedonic design elements, *points* are the most commonly used design element (see Table 4.6). There is hardly any gamified application that does not use points, whereas points are rather uncommon in serious games. As a kind of virtual currency earned through desired behavior, points can be used to express progress when there are no concrete metrics (e.g., energy savings or steps). Points are often used in combination with *leaderboards* (e.g., [81], [310], [319]), a social design element, as a primary measure for comparing peer performance.

[81]: Kotsopoulos *et al.* (2020)
[310]: Viberg *et al.* (2020)
[319]: Barna *et al.* (2018)

Generally, studies use a variety of achievement-related design elements. In addition to points, *badges* are often introduced as virtual rewards for achievements in the gamified application and can be earned on an individual and team basis [293], for example. They are typically displayed on a personal profile (e.g., [293], [319]) or dashboard [301]), but can also be presented in a more narrative form, e.g., as *interactive animations* that augment a virtual garden [84] or birds that appear in a virtual tree [81]. In some studies, achievements are also expressed in the form of *certificates* awarded to employees outside the application [319], [304].

[293]: Mamede *et al.* (2021)
[301]: Jent *et al.* (2016)
[84]: Oppong-Tawiah *et al.* (2020)
[304]: Newcomb *et al.* (2019)

It is noteworthy that nearly one-third of the studies also use *real-world rewards* as extrinsic incentives for participation and engagement in the gamified intervention. The extent of rewards varies widely across studies, ranging from free meals [86] to material gifts [69] and lottery tickets [81] to an increase in annual compensation [304] and other monetary rewards [89].

[86]: Iria *et al.* (2020)
[69]: Kouwenhoven-Pasmooij *et al.* (2017)

In contrast, only two studies introduced punishments for bad decisions, but these were limited to virtual punishments, e.g., an accumulation of viruses in a serious game for Covid-19 protection [325], and did not translate to the real world.

[325]: Suppan *et al.* (2021)

In addition, *levels* represent an element of game design to express progress in behavior change by dividing advancement into milestones that can be achieved. They are sometimes coupled with *adaptive difficulty*, such that the difficulty of the task increases as a new level is reached [300], linked to *scenarios* (where different levels contain different scenarios [363]), or combined with *storytelling* (e.g., different levels are represented in the form of cities explored through walking activities [68]). As another element of progress tracking, *progress bars* are a hedonic way of representing progress on a particular task or process, e.g., submitting an idea [310], assembling a

[300]: Korn *et al.* (2016)
[363]: Suppan *et al.* (2020)
[310]: Viberg *et al.* (2020)

**Table 4.6:** Hedonic design elements used in the reviewed articles.

| Cluster | No. | Articles |
|---|---|---|
| Points | 28 | [68], [69], [75]–[78], [81], [86], [88], [293], [301], [305], [307]–[312], [315]–[317], [319], [321]–[326] |
| Storytelling | 24 | [68]–[70], [73], [75]–[77], [81], [82], [84], [86], [88], [293], [299], [302], [306], [308], [314], [315], [319], [324]–[327] |
| Badges | 21 | [68], [69], [75]–[77], [81], [82], [88], [292], [293], [301], [303]–[305], [307], [309], [317], [319], [322], [323], [328] |
| Rewards | 17 | [69], [78], [79], [81], [86], [89], [292], [293], [303], [304], [311], [317], [321]–[324], [328] |
| Progress bar | 9 | [75]–[77], [81], [299], [301], [310], [311], [327] |
| Time limit | 7 | [88], [299], [300], [308], [323], [327], [362] |
| Adaptive difficulty | 7 | [81], [89], [293], [299], [300], [320], [327] |
| Levels | 7 | [68], [78], [86], [300], [304], [319], [325] |
| Scenarios | 6 | [306], [308], [314], [324], [326], [363] |
| Turns | 6 | [75]–[77], [302], [315], [316] |
| Quiz | 6 | [68], [78], [79], [88], [301], [308] |
| Unlockable content | 5 | [75]–[77], [301], [304] |
| Shuffling/Chance | 5 | [75]–[77], [302], [315] |
| Roleplay | 5 | [74], [302], [306], [315], [326] |
| Motivational message | 6 | [70], [86], [285], [292], [312], [320] |
| Avatar | 4 | [70], [82], [293], [320] |
| Certificate | 2 | [304], [319] |
| Punishments | 2 | [317], [325] |
| Shadow of own performance | 2 | [299], [327] |
| Personalization | 2 | [308], [311] |
| Ambient sound | 2 | [71], [306] |
| Virtual environment | 1 | [71] |
| Rating | 1 | [301] |
| Creative expression | 1 | [73] |
| Anonymization | 1 | [324] |
| Events | 1 | [82] |
| Interactive animations | 1 | [84] |

tool [299], [327], or completing a challenge [311].

On the other hand, hedonic design elements are used in studies to evoke immersion and emotional attachment. *Storytelling* is predominantly used in serious games where the learner is placed in different *scenarios*, such as emergency situations [308], [314] and care situations [306], [324], [325]. However, storytelling is also implemented in the form of narratives, such as "cooking an idea with the right recipes" in gamified workshops for idea generation [75]–[77], and used in gamified applications, for example. e.g., in the form of a garden or tree that evolves by saving energy [81], [84] or virtual cities visited through physical activity [68]. In addition, storytelling is used to design competitive challenges, e.g., real-time energy efficiency competitions are visualized in the form of virtual soccer matches between employees [86]. Combined with VR technology, employees can also be taken to a completely *virtual environment* separate from the real workplace, such as a virtual forest, to relieve stress [71], and *ambient sounds* can help convey the atmosphere of the virtual environment [71], [306].

*Roleplay* is often combined with storytelling and scenarios and used in serious games to convey different perspectives in a given situation, e.g., about attackers and defenders in cybersecurity [315], different actors in innovation processes [74], [302], or different tasks in healthcare [306].

[299]: Korn *et al.* (2014)
[327]: Korn *et al.* (2015)

[311]: Nuijten *et al.* (2022)

[308]: Tuti *et al.* (2020)
[314]: Heldal (2016)

[306]: Jackson *et al.* (2020)
[324]: Strong *et al.* (2021)
[325]: Suppan *et al.* (2021)

[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[77]: Patricio *et al.* (2022)

[81]: Kotsopoulos *et al.* (2020)
[84]: Oppong-Tawiah *et al.* (2020)

[68]: Dadaczynski *et al.* (2017)

[86]: Iria *et al.* (2020)

[71]: Ladakis *et al.* (2021)

[315]: Hart *et al.* (2020)

Moreover, *avatars* are a design element used in studies to represent employees in virtual space. For example, one study uses facial recognition technology to display an avatar that looks like the employee currently using the application in an energy-saving application [82]. Yet avatars can also represent non-player characters, such as a virtual counselor in a mental health chatbot application [70].

[74]: Agogué *et al.* (2015)
[302]: Janocha *et al.* (2018)
[82]: Lou *et al.* (2019)
[70]: Hungerbuehler *et al.* (2021)

In order to promote continuous engagement with the gamified intervention and to avoid boredom, studies use elements of adaptive difficulty, unlockable content, or motivational messages. *Adaptive difficulty* describes a mechanic of the gamified system in which tasks, for example assembly tasks [299], [327] or physical activity [320], start easy but become more difficult over time. Two notable studies have *personalized* difficulty and feedback based on employees' individual knowledge [308] and fitness levels [311]. In some studies, employees can also *unlock* new (and more difficult) tasks or challenges that were not available from the beginning by progressing in the application or attaining certain achievements [75]–[77], [301], [304]. Furthermore, *motivational messages* are used to elicit positive emotional experiences (e.g., "You did great!"), mostly to encourage continued involvement in physical activity [70], [285], [292], [312], [320].

[299]: Korn *et al.* (2014)
[327]: Korn *et al.* (2015)
[308]: Tuti *et al.* (2020)
[311]: Nuijten *et al.* (2022)
[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[77]: Patricio *et al.* (2022)
[301]: Jent *et al.* (2016)
[304]: Newcomb *et al.* (2019)
[70]: Hungerbuehler *et al.* (2021)
[285]: Lier *et al.* (2019)
[292]: Nagata *et al.* (2022)
[312]: Zhang *et al.* (2021)
[320]: Gremaud *et al.* (2018)

For learning purposes, *quizzes* represent a hedonic way of imparting information, e.g., on energy conservation [78], [79] or on reactions in medical emergencies [308]. Quizzes are also sometimes used as part of gamified workshops, e.g., on sustainable supply chain management [88].

[78]: Hafer *et al.* (2017)
[79]: Kaselofsky *et al.* (2020)
[88]: Putz *et al.* (2018)

Finally, there are several hedonic mechanisms that are mostly used in serious game interventions or gamified workshops. *Time limit* describes a mechanic that challenges employees to complete a task in a certain amount of time. For example, employees must assemble a tool within a certain time frame, with a color-changing circle or a stackable Tetris board indicating how much time is left [299], [327]. In this context, Korn et al. also show a *shadow of prior performance* as a means of self-comparison in the assembly task [299], [327]. Last, *turns* and *shuffling or chance* are mechanisms used in tabletop and card games in which workers draw cards in sequence [315] or roll dice [302], [75]–[77] that steer the game in unpredictable directions.

[315]: Hart *et al.* (2020)
[302]: Janocha *et al.* (2018)

### Social Elements

Third, the studies use a variety of social design elements to encourage social interaction among employees. Notably, most social design elements are competitive rather than collaborative, with the most commonly used social design elements being challenges and leaderboards.

*Challenges* are a playful way to present goals that employees are expected to achieve in a given time period, competing against each other to be the first to complete the challenge. Challenges are the main element of gamified campaigns [79], [87], [89], [292] but are also commonly used in gamification applications for web browsers [68], [301], [307], [319] and smartphones [293], [312].

[87]: Wunsch *et al.* (2016)
[89]: Respati *et al.* (2018)
[68]: Dadaczynski *et al.* (2017)
[307]: Nguyen *et al.* (2020)
[319]: Barna *et al.* (2018)
[293]: Mamede *et al.* (2021)
[312]: Zhang *et al.* (2021)

*Leaderboards*, unlike challenges, represent a form of social comparison based on the overall progress of the user rather than a specific goal. Leaderboards show individual users and their earned points (e.g., [72],

Table 4.7: Social design elements used in the reviewed articles.

| Cluster | No. | Articles |
|---|---|---|
| Challenge (Competition) | 23 | [68], [69], [75]–[77], [79], [81], [82], [86]–[89], [285], [292], [293], [303], [310], [311], [319]–[323] |
| Leaderboard | 22 | [68], [72], [81], [82], [86]–[88], [293], [301], [303], [307], [310]–[312], [316], [317], [319]–[324] |
| Teams | 17 | [68], [69], [72], [75]–[77], [81], [82], [86]–[88], [293], [303], [311], [321]–[323] |
| Social sharing (posting, commenting, newsfeed) | 8 | [79], [89], [309]–[311], [319], [322], [323] |
| Discussion on ideas | 5 | [73], [74], [79], [302], [362] |
| Direct comparison | 3 | [78], [301], [303] |
| Trading | 3 | [75]–[77] |
| Forum | 2 | [69], [309] |
| Status/Rank | 2 | [81], [304] |
| Voting | 2 | [74], [316] |
| Event organization | 1 | [319] |
| Support partner | 1 | [72] |
| Chat | 1 | [322] |
| Team roles | 1 | [81] |
| Leagues | 1 | [320] |
| Knowledge sharing | 1 | [79] |

[312], or their key metrics (e.g., steps traveled [320] or energy consumption [86]). They are used in almost every gamified application, while they are uncommon in serious games (with the exception of [316], [324]). To account for individual starting situations, one study also used different leagues to divide workers for fair competition [320].

Other forms of social comparison used in the studies include status ranks displayed on peer profiles [81] or employee identification cards [304], and opportunities for direct comparison, e.g., of key measures [78] or of knowledge in competitive quizzes [301].

Among the collaboration-oriented elements, teams of employees are often used as a cooperative form of play to achieve common goals in a cooperative-competitive manner. For example, teams compete against each other to overcome physical challenges [293], or different companies form teams to compete in a ranking in terms of cycling kilometers driven [87]. On the other hand, teams are also used in gamified workshops [75]–[77], [88] to promote collaborative work on ideas. In this context, employees often discuss ideas and possible behaviors [73], [74], [302] and in some studies also vote on the results of the discussion, e.g., on the best idea [74] or the best response to cybersecurity issues [316]. Notably, in innovation workshops, Patricio et al. also introduced the collaborative mechanic of trading as part of their idea card game, meaning that players can trade cards to achieve an overall better outcome as a team [75]–[77].

Finally, social networking and knowledge sharing features are elements designed to enable mutual support among employees. Social networking features strongly resemble the design of commonly known social networks such as Facebook and LinkedIn, and thus include social feeds of peer activities where employees post their own pictures and like or comment on the actions of others [79], [89], [309]–[311], [319], [322], [323]. On the other hand, forums [69] [309] and chats [322] are presented as tools for social and knowledge exchange on the topic. The energy saving competition by

[72]: Waddell *et al.* (2021)
[312]: Zhang *et al.* (2021)

[320]: Gremaud *et al.* (2018)

[86]: Iria *et al.* (2020)

[316]: Omiya *et al.* (2019)
[324]: Strong *et al.* (2021)

[81]: Kotsopoulos *et al.* (2020)

[304]: Newcomb *et al.* (2019)

[78]: Hafer *et al.* (2017)

[301]: Jent *et al.* (2016)

[293]: Mamede *et al.* (2021)

[87]: Wunsch *et al.* (2016)

[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[77]: Patricio *et al.* (2022)
[88]: Putz *et al.* (2018)

[73]: Cheng *et al.* (2022)
[74]: Agogué *et al.* (2015)
[302]: Janocha *et al.* (2018)

[79]: Kaselofsky *et al.* (2020)
[89]: Respati *et al.* (2018)
[309]: Nivedhitha *et al.* (2020)
[310]: Viberg *et al.* (2020)
[311]: Nuijten *et al.* (2022)
[319]: Barna *et al.* (2018)
[322]: Shahrestani *et al.* (2017)
[323]: McKeown *et al.* (2016)

Kaselofsky et al. [79] additionally organized a conference where contest winners shared their experiences and methods of success with colleagues and the broader community.

[69]: Kouwenhoven-Pasmooij *et al.* (2017)

[79]: Kaselofsky *et al.* (2020)

### 4.4.4 Psychological Outcomes

Psychological outcomes (**RQ3**) in the studies analyzed are cognitive or affective states induced by the utilitarian, hedonic, and social design elements analyzed in the previous section. Following the goal-framing theory [133] and the TPB [166], I identified 23 psychological outcomes examined in studies of gamification for sustainable employee behavior (Table 4.8, Table 4.9), most of which can be related to hedonic goal frames, i.e., positive emotional experiences during participation in the gamified intervention [133].

[133]: Lindenberg *et al.* (2013)

[166]: Ajzen (1991)

#### Hedonic Goal Frame

For the hedonic goal frame, several studies examined the effects of gamification on motivation and fun during the behavior change intervention. Regarding *fun*, the results seem to be unanimously positive in both quantitative [82], [316], [319], [320] and qualitative [77], [321] studies. However, the effects of gamification on *motivation* are fairly mixed. Studies in the areas of energy conservation [79], [82], physical activity [320], and cybersecurity [316] have found positive effects on motivation. However, Shahrestani et al. note that half of their participants rated the gamified application as highly motivating for physical activity behavior, while the other half disagreed [322]. Jent et al. observed that some gamification elements, such as progress bars, were found to be motivating by employees, while others, such as tips of the day or badges, did not have the same effect [301].

[82]: Lou *et al.* (2019)
[316]: Omiya *et al.* (2019)
[319]: Barna *et al.* (2018)
[320]: Gremaud *et al.* (2018)

[77]: Patricio *et al.* (2022)
[321]: Hammedi *et al.* (2021)

[79]: Kaselofsky *et al.* (2020)

[322]: Shahrestani *et al.* (2017)

[301]: Jent *et al.* (2016)

Studies have shown that gamification can elicit a variety of positive experiences, supporting, for example, *enjoyment* in energy-saving behaviors [84], the experience of *surprise* in idea workshops [74], [77], and *immersion* in system use [310], and fostering *feelings of support* [320] and *challenge* [316].However, other studies also pointed to potentially negative side effects of gamification in work environments. For example, performance transparency in gamified systems can put *pressure* on employees [298], reduce *job satisfaction* [321], and negatively impact a *trustworthy* workplace atmosphere [85]. Finally, there are conflicting studies on the psychological outcomes that can be associated with flow experience [330]. While Niveditha et al. observed a positive effect of gamification on *transcendent experience* [362], Viberg et al. identified negative effects on the *perception of time*, which argues against flow [310].

[84]: Oppong-Tawiah *et al.* (2020)

[74]: Agogué *et al.* (2015)
[77]: Patricio *et al.* (2022)

[310]: Viberg *et al.* (2020)

[298]: Shahri *et al.* (2014)

[321]: Hammedi *et al.* (2021)

[85]: Stroud *et al.* (2020)

[330]: Csikszentmihalyi (1975)

[362]: Nivedhitha (2022)

#### Gain Goal Frame

Although several studies drew on TPB, TRA, or self-efficacy theory to design their gamified interventions, surprisingly few studies assess the impact of gamification on related gain-oriented psychological behavioral determinants that precede behavioral intention to change. Two studies identified positive effects on *attitude* toward sustainable supply chain management

[88] and *interest* in energy conservation [79], while three studies examined the effect of gamification on concepts related to perceptions of behavioral control, i.e., *self-efficacy* [68], [311] (where Dadaczynski et al. [68] found positive effects on self-efficacy for physical activity, and Nuijten et al. [311] found no effects) and *self-regulation* [312].

[88]: Putz *et al.* (2018)
[79]: Kaselofsky *et al.* (2020)
[68]: Dadaczynski *et al.* (2017)
[311]: Nuijten *et al.* (2022)
[312]: Zhang *et al.* (2021)

#### Normative Goal Frame

In comparison, cognitive outcomes related to awareness and knowledge of sustainable behaviors, thus supporting the normative goal frame [133], have been examined in several studies. In terms of *awareness*, studies have found positive effects of gamification on awareness of the importance of energy conservation [82], [84], resilient health care [306], mental and physical health [312], [322], and addressing malnutrition [74]. It has also been shown that serious games and gamified applications can promote *reflection* [306], *intellectual experiences* [362], and *discriminative thinking* [73]. On the other hand, while the majority of studies report positive outcomes related to *learning* healthy lifestyles [68], health practices [308], [324], cybersecurity [315], and energy conservation [78], other studies have found only mixed [316], [326] or no effects [74], [306].

[133]: Lindenberg *et al.* (2013)
[82]: Lou *et al.* (2019)
[84]: Oppong-Tawiah *et al.* (2020)
[306]: Jackson *et al.* (2020)
[322]: Shahrestani *et al.* (2017)
[74]: Agogué *et al.* (2015)
[362]: Nivedhitha (2022)
[73]: Cheng *et al.* (2022)
[308]: Tuti *et al.* (2020)
[324]: Strong *et al.* (2021)
[315]: Hart *et al.* (2020)
[78]: Hafer *et al.* (2017)
[316]: Omiya *et al.* (2019)
[326]: Pasini *et al.* (2022)

#### Behavioral Intention

Finally, six studies investigated whether the gamified intervention influences *behavioral intention* to engage in further behavior change, with coherently positive results on intention to exercise [68], [322], save energy [84], apply Covid-19 protection measures [325], adopt cybersecurity measures [315] and use sustainable transportation in supply chain management [88].

[325]: Suppan *et al.* (2021)
[88]: Putz *et al.* (2018)

#### System-Related Psychological Outcomes

During coding, system-related psychological outcomes, which do not primarily relate to intended behavior but rather to perceptions of the gamified system itself, emerged as an additional category of psychological outcomes most often examined in design studies. Because these outcomes invariably relate to the *usefulness* [84], [314], [315], [322] *ease of use* [310], [315], [320], or *usability* [322], [326] of a particular system, it is difficult to draw generalizable conclusions. Overall, the perception of gamification in the analyzed studies seems to be fairly mixed, which is also reflected in the mostly mixed results regarding *user experience* [71], [300], [307], [314], [316], [326].

[314]: Heldal (2016)
[310]: Viberg *et al.* (2020)
[320]: Gremaud *et al.* (2018)
[71]: Ladakis *et al.* (2021)
[300]: Korn *et al.* (2016)
[307]: Nguyen *et al.* (2020)

### 4.4.5 Behavioral Outcomes

When it comes to behavioral outcomes of studies on gamification for sustainable employee behavior (**RQ4**), three categories of behavioral effects can be identified: individual behavioral outcomes, social behavioral outcomes, and psycho-physiological outcomes of behavior change.

Table 4.8: (Goal-framing related) psychological outcomes investigated in the reviewed articles (+ = positive, o = no effect, ± = mixed, - = negative).

| Outcome | No. | + (sig.) | + (desc.) | + (qual.) | o (desc.) | o (qual.) | ± (sig.) | ± (desc.) | ± (qual.) | - (sig.) | - (desc.) | - (qual.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hedonic goal frame** | | | | | | | | | | | | |
| Motivation | 8 | | [79], [82], [316], [320] | [310] | | | | [301], [322] | [321] | | | |
| Fun | 6 | | [82], [316], [319], [320] | [77], [321] | | | | | | | | |
| Stress | 2 | | [303] | [321] | | | | | | | | |
| Surprise | 2 | | | [74], [77] | | | | | | | | |
| Enjoyment | 1 | | [84] | | | | | | | | | |
| Pressure | 1 | | | [298] | | | | | | | | |
| Transcendent experience | 1 | [309] | | | | | | | | | | |
| Mood | 1 | | | | [71] | | | | | | | |
| Perception of time | 1 | | | | | | | | | | [310] | |
| Immersion | 1 | | [310] | | | | | | | | | |
| Job satisfaction | 1 | | | | | | | | | [321] | | |
| Feeling of support | 1 | | [320] | | | | | | | | | |
| Trust | 1 | | | | | | | | | | | [85] |
| Feeling of challenge | 1 | | [316] | | | | | | | | | |
| **Gain goal frame** | | | | | | | | | | | | |
| Self-efficacy | 2 | [68] | | | [311] | | | | | | | |
| Self-regulation | 1 | | | [312] | | | | | | | | |
| Attitude | 1 | [88] | | | | | | | | | | |
| Interest | 1 | | [79] | | | | | | | | | |
| **Normative goal frame** | | | | | | | | | | | | |
| Learning | 9 | [68], [324] | [78], [308], [315] | | [306] | [74] | | [316], [326] | | | | |
| Awareness | 6 | | [82], [306] | [74], [84], [312], [322] | | | | | | | | |
| Reflection | 1 | | [306] | | | | | | | | | |
| Discriminative thinking | 1 | [73] | | | | | | | | | | |
| Intellectual experience | 1 | [309] | | | | | | | | | | |
| Behavioral intention | 6 | [68], [88], [325] | [84], [315], [322] | | | | | | | | | |

Table 4.9: (System-related) psychological outcomes investigated in the reviewed articles (+ = positive, o = no effect, ± = mixed, - = negative).

| Outcome | No. | + (sig.) | + (desc.) | + (qual.) | o (desc.) | o (qual.) | ± (sig.) | ± (desc.) | ± (qual.) | - (sig.) | - (desc.) | - (qual.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| User experience | 9 | | [78] | [84], [306] | | | | [71], [300], [307], [316], [326] | [314] | | | |
| Usefulness | 4 | | [84], [315], [322] | | | | | | [314] | | | |
| Ease of use | 3 | | [315], [320] | [310] | | | | | | | | |
| Usability | 2 | | | | | | | [326] | [322] | | | |

[304]: Newcomb *et al.* (2019)
[306]: Jackson *et al.* (2020)
[70]: Hungerbuehler *et al.* (2021)
[89]: Respati *et al.* (2018)
[79]: Kaselofsky *et al.* (2020)
[84]: Oppong-Tawiah *et al.* (2020)
[322]: Shahrestani *et al.* (2017)
[324]: Strong *et al.* (2021)
[82]: Lou *et al.* (2019)
[293]: Mamede *et al.* (2021)
[68]: Dadaczynski *et al.* (2017)
[311]: Nuijten *et al.* (2022)
[321]: Hammedi *et al.* (2021)
[327]: Korn *et al.* (2015)
[312]: Zhang *et al.* (2021)
[285]: Lier *et al.* (2019)
[292]: Nagata *et al.* (2022)
[293]: Mamede *et al.* (2021)
[303]: Lowensteyn *et al.* (2019)
[319]: Barna *et al.* (2018)
[320]: Gremaud *et al.* (2018)
[74]: Agogué *et al.* (2015)
[75]: Patricio *et al.* (2020)
[77]: Patricio *et al.* (2022)
[362]: Nivedhitha (2022)
[73]: Cheng *et al.* (2022)
[299]: Korn *et al.* (2014)
[327]: Korn *et al.* (2015)
[323]: McKeown *et al.* (2016)
[325]: Suppan *et al.* (2021)

### Individual Behavior Outcomes

Several studies have examined the effects of gamification on individual behavior. Specifically, a number of studies found positive effects of gamified interventions on *engagement* in behavior change, for example, in energy saving behaviors [82], improved health practices [304], [306], and healthy behaviors [70], [89]. Similarly, four studies observed positive effects on *perceived behavior change* [79], [84], [322], [324]. However, there are also studies indicating lack of [311], [82], [293] or mixed effects [68], [311], [321], [327] on engagement and perceived behavior change as well as current stage of behavior change [312]. Regarding the specific behaviors studied, studies provided good evidence of positive effects of gamified applications on employees' *physical activity* [285], [292], [293], [303], [319], [320], including *fitness tracker wear* [320], *creativity* [74], [75], [77], [362], and *coping flexibility* [73]. The *time required for task completion* also reduced at augmented gamified workplaces [299], [327].

On the other hand, gamification appears to have mixed [321] or even negative effects [299], [327] on *job performance*. In addition, there were no measurable improvements in health care *sepsis management* [323] and *Covid-19 protective measures* [325], which is particularly interesting given that the study by McKeown et al. [323] reported a variety of positive effects at the corporate level that were hypothesized to result from behavior change.

[78]: Hafer *et al.* (2017)
[74]: Agogué *et al.* (2015)

### Social Behavior Outcomes

In general, few studies have examined the effects of gamification on social behavior, but those that have done so report predominantly positive results. While the evidence on word of mouth for behavior change [78], successful knowledge transfer [74], and challenging ideas [74] is inconclusive, there appears to be a variety of positive effects related to colleague interaction.

[316]: Omiya *et al.* (2019)
[76]: Patrício *et al.* (2021)
[89]: Respati *et al.* (2018)
[302]: Janocha *et al.* (2018)
[73]: Cheng *et al.* (2022)

To this end, studies have found that gamification has a positive impact on social interaction [316], [76], communication [75], [76], networking [319], and social sharing [89]. At the team level, gamified interventions also promote team building [74], [77], team dynamics [302], especially group cohesion [73] and consensus building [77], and team effectiveness [73].

Table 4.10: (Individual and social) behavioral outcomes investigated in the reviewed articles (+ = positive, o = no effect, ± = mixed, - = negative).

| Outcome | No. | + (sig.) | + (desc.) | + (qual.) | o (desc.) | o (qual.) | ± (sig.) | ± (desc.) | ± (qual.) | - (sig.) | - (desc.) | - (qual.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Individual behavior outcomes** | | | | | | | | | | | | |
| Engagement | 11 | | [70], [82], [89], [304], [306], [317] | [76], [77] | [311] | | [321], [327] | | | | | |
| Behavior change | 8 | | [79], [324] | [84], [322] | [82], [293] | | [311] | [72] | | | | |
| Physical activity | 8 | [285], [293] | [292], [303], [319], [320] | | | | [311] | [68] | | | | |
| Creativity | 4 | [309] | | [74], [75], [77] | | | | | | | | |
| Job performance | 3 | | | | | | [321] | | | [299] | [327] | |
| Job time | 2 | | [299], [327] | | | | | | | | | |
| Sedentary behavior | 1 | | | | [293] | | | | | | | |
| Stage of change | 1 | | | | | | [312] | | | | | |
| Covid-19 protection measures | 1 | | | | [325] | | | | | | | |
| Sepsis management | 1 | | | | | | | [323] | | | | |
| Wearing a fitbit | 1 | | [320] | | | | | | | | | |
| Coping flexibility | 1 | [73] | | | | | | | | | | |
| **Social behavior outcomes** | | | | | | | | | | | | |
| Word of mouth | 3 | | [306], [322] | | [78] | | | | | | | |
| Knowledge sharing | 2 | | | [74], [77] | | | | | | | | |
| Social interaction | 2 | | [316] | [76] | | | | | | | | |
| Communication | 2 | | | [75], [76] | | | | | | | | |
| Team building | 2 | | | [74], [77] | | | | | | | | |
| Networking | 1 | | [319] | | | | | | | | | |
| Group cohesion | 1 | [73] | | | | | | | | | | |
| Team dynamic | 1 | | | [302] | | | | | | | | |
| Team effectiveness | 1 | [73] | | | | | | | | | | |
| Consensus building | 1 | | | [77] | | | | | | | | |
| Knowledge transfer | 1 | | | | | [74] | | | | | | |
| Social sharing | 1 | | [89] | | | | | | | | | |
| Challenging ideas | 1 | | | | | | | | [74] | | | |

Furthermore, gamification can support knowledge sharing [74], [77] in ideation contexts.

[74]: Agogué *et al.* (2015)
[77]: Patricio *et al.* (2022)

### Psycho-physiological Outcomes of Behavior Change

Finally, studies in the area of employee health and well-being, particularly from the field of health informatics, examined intervention outcomes on psycho-physiological measures influenced by behavior change.

At the psychological level, studies found positive effects of gamified interventions on *well-being* [305] and *mental health* [322] and negative effects on *stress* [71]. No effects were found for clinical mental health issues, such as *depression* [303], [305].

[322]: Shahrestani *et al.* (2017)
[71]: Ladakis *et al.* (2021)
[303]: Lowensteyn *et al.* (2019)
[305]: Brown *et al.* (2020)

At the physiological level, studies reported improvements in *physical health* [322], particularly *blood pressure* [303], [292], *cardiovascular age gap* [303], and *fatigue* [303]. Regarding *sleep* [303], [72] and *cholesterol ratio* [292], [303], the evidence remains mixed.

[292]: Nagata *et al.* (2022)
[72]: Waddell *et al.* (2021)

Table 4.11: Psycho-physiological outcomes of behavior change investigated in the reviewed articles (+ = positive, o = no effect, ± = mixed, - = negative).

| Outcome | No. | + (sig.) | + (desc.) | + (qual.) | o (desc.) | o (qual.) | ± (sig.) | ± (desc.) | ± (qual.) | - (sig.) | - (desc.) | - (qual.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Overweight | 3 | | | | [303] | | | | | | [69], [292] | |
| Depression | 2 | | | | [303], [305] | | | | | | | |
| Sleep | 2 | | [303] | | [72] | | | | | | | |
| Cholesterol ratio | 2 | | [303] | | [292] | | | | | | | |
| Blood pressure | 2 | | [292], [303] | | | | | | | | | |
| Heart rate | 1 | | | | [71] | | | | | | | |
| Cardiovascular age gap | 1 | | | | | | | | | | [303] | |
| Fatigue | 1 | | | | | | | | | | [303] | |
| Well-being | 1 | | [305] | | | | | | | | | |
| Stress | 1 | | | | | | | | | | [71] | |
| Physical health | 1 | | [322] | | | | | | | | | |
| Mental health | 1 | [322] | | | | | | | | | | |

## 4.4.6 Corporate Outcomes

Finally, while studies have examined fewer than psychological or behavioral outcomes, they have also discovered a variety of corporate-level outcomes, i.e., effects of cumulative individual and social behavioral changes (RQ5). Another notable observation is that the psychological and behavioral outcomes are not unanimously positive, and the studies also often report mixed or no effects, while all of the corporate outcomes examined are essentially positive (with the exception of some culture and social interaction level outcomes).

A total of five studies examined the outcome of a gamified intervention on corporate energy consumption (SDG 7). In particular, they found positive effects on *electricity consumption* of buildings and electronic devices [78], [79], [82], [86] and some positive effects on *heat consumption* of buildings [79].

[78]: Hafer *et al.* (2017)
[79]: Kaselofsky *et al.* (2020)
[82]: Lou *et al.* (2019)
[86]: Iria *et al.* (2020)

In addition, four studies (three of which, it should be noted for transparency, originate from the same author and use the same gamified workshop) investigated how gamification can affect innovation processes in companies (SDG 9). The mostly qualitative studies reported positive effects on the generation of new ideas *(ideation)* [75]–[77], *structuring of ideas* [75], [77], *decisions for ideas* [76], and *time to action* [77]. Also, a quantitative study by Colabi et al. [313] found positive relationships between the use of gamification in innovation processes and *digital transformation, value co-creation,* and *open innovation*.

[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[77]: Patricio *et al.* (2022)

[313]: Colabi *et al.* (2022)

In relation to SDG 3, good health and well-being, a study by McKeown et al. [323] examined how a gamified campaign among health care professionals affected several key metrics indicating quality of care. They found negative effects of gamification on *patient mortality, patient revisits,* and *length of patient stay*, all of which indicate an increase in quality of care.

[323]: McKeown *et al.* (2016)

During coding, workplace culture and social interaction emerged as another category of corporate outcomes from gamification interventions. Similar to certain negative impacts of gamification on trust at the psychological level [85], some studies suggest mixed [321] or even negative [85], [298] impacts on *colleague relationships, privacy,* and *workplace atmosphere*. In particular, gamification may even pose the risk of employee *exploitation* [298]. However, consistent with several positive social behavioral outcomes, other studies found rather positive effects on colleague relationships, workplace atmosphere [319], *supervisor support* [79], *employee retention* [304], and *hierarchy reduction* [302]. Therefore, the impact of gamification on culture and social interaction seems to depend on the design of the intervention and the pre-existing workplace culture.

[321]: Hammedi *et al.* (2021)

[85]: Stroud *et al.* (2020)
[298]: Shahri *et al.* (2014)

[319]: Barna *et al.* (2018)

[304]: Newcomb *et al.* (2019)

[302]: Janocha *et al.* (2018)

Finally, two studies also considered the economic perspective of companies. The studies by Strong et al.[324] and McKeown et al. [323] in the health care sector found that improved care through gamification can lead to *economic savings* as well as lower *pharmacy* and *risk-adjusted costs*.

[324]: Strong *et al.* (2021)

## 4.5 Discussion

To the best of the author's knowledge, this review is the first to systematically analyze previous research on gamification and game-based interventions to promote sustainable employee behavior in the workplace. By carefully analyzing the prevailing research topics, research approaches, theoretical foundations used, gamification design, and the results of previous studies at the psychological, behavioral, and corporate levels, it synthesizes the current state of scientific knowledge on gamification as a tool for promoting sustainable employee behavior in the workplace while highlighting research avenues that deserve further attention. In this way, this study contributes to shaping future research efforts in gamification

Table 4.12: Corporate outcomes investigated in the reviewed articles (+ = positive, o = no effect, ± = mixed, - = negative).

| Outcome | No. | + (sig.) | + (desc.) | + (qual.) | o (desc.) | o (qual.) | ± (sig.) | ± (desc.) | ± (qual.) | - (sig.) | - (desc.) | - (qual.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Energy consumption (SDG 7)** | | | | | | | | | | | | |
| Electricity consumption | 5 | [84] | [78], [79], [82], [86] | | | | | | | | | |
| Heat consumption | 1 | | | | | | | [79] | | | | |
| **Innovation (SDG 9)** | | | | | | | | | | | | |
| Ideation | 3 | | | [75]–[77] | | | | | | | | |
| Idea structuring | 2 | | | [75], [77] | | | | | | | | |
| Better decisions | 1 | | | [76] | | | | | | | | |
| Time to action | 1 | | | [77] | | | | | | | | |
| Digital transformation | 1 | [313] | | | | | | | | | | |
| Value co-creation | 1 | [313] | | | | | | | | | | |
| Open innovation | 1 | [313] | | | | | | | | | | |
| **Quality of care (SDG 3)** | | | | | | | | | | | | |
| Patient mortality | 1 | | | | | | | | | | [323] | |
| Patient revisits | 1 | | | | | | | | | | [323] | |
| Length of patient stay | 1 | | | | | | | | | | [323] | |
| **Culture and social interaction** | | | | | | | | | | | | |
| Colleague relationships | 4 | | [319] | | | | | | [321] | | | [85], [298] |
| Workplace atmosphere | 2 | | [319] | | | | | | [321] | | | |
| Supervisor support | 1 | | [79] | | | | | | | | | |
| Employee retention | 1 | | [304] | | | | | | | | | |
| Hierarchy reduction | 1 | | | [302] | | | | | | | | |
| Employee exploitation | 1 | | | [298] | | | | | | | | |
| Privacy | 1 | | | | | | | | | | | [298] |
| **Economic benefits** | | | | | | | | | | | | |
| Economic savings | 1 | | [324] | | | | | | | | | |
| Pharmacy costs | 1 | | | | | | | | | | [323] | |
| Risk-adjusted costs | 1 | | | | | | | | | | [323] | |

for sustainable employee behavior and derives valuable recommendations for practitioners in designing gamified interventions to engage their employees in workplace sustainability.

In terms of the thematic focus of existing studies, it becomes apparent that research efforts have largely focused on a relatively narrow understanding of sustainable behaviors. Critically juxtaposing the topics of previous studies with the SDGs, it is evident that half of all studies addressed SDG 3 by focusing on how gamified approaches can support employees' physical activity, well-being, and healthy lifestyles in the workplace. A particular subtopic that has gained attention in this context in recent years is how gamified campaigns and applications can improve the quality of health care, which is a goal of SDG 3 [304], [323], [324]. In addition, SDG 9 and SDG 7 were targeted by studies that examined how gamification, specifically gamified ideation workshops [74]–[77], can support innovation in organizations and the ways in which gamified applications can promote energy-saving behaviors among employees in the workplace [78]–[86]. In contrast, few studies focus on the potential contribution of gamification to reducing inequalities (SDG 10) in the work environment, supporting strong institutions and addressing unlawful acts (SDG 16), promoting sustainable commuting, transportation, or supply chain management (SDG 12), and promoting responsible consumption of natural resources, including waste management, in the workplace (SDG 12). In addition, there are no empirical studies to date that have examined potential effects of gamification on sustainable behaviors in other dimensions that may be performed by employees in the workplace, such as water conservation (SDG 6), gender equality (SDG 5), or climate change mitigation (SDG 13). Finally, none of the studies reviewed considered addressing more than one specific sustainability issue and thus ceased to take a holistic perspective on sustainable behavior in the workplace. Therefore, I propose the following initial thematic agenda item for future research in the area of gamification for sustainable employee behavior:

[304]: Newcomb *et al.* (2019)
[323]: McKeown *et al.* (2016)
[324]: Strong *et al.* (2021)

[74]: Agogué *et al.* (2015)
[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[77]: Patricio *et al.* (2022)

[78]: Hafer *et al.* (2017)
[79]: Kaselofsky *et al.* (2020)
[80]: Kotsopoulos *et al.* (2017)
[81]: Kotsopoulos *et al.* (2020)
[82]: Lou *et al.* (2019)
[83]: Lounis *et al.* (2017)
[84]: Oppong-Tawiah *et al.* (2020)
[85]: Stroud *et al.* (2020)
[86]: Iria *et al.* (2020)

**Agenda point 1:** Future research should explore the potential of gamification to support sustainable employee behaviors in the workplace more holistically, particularly with regard to reducing inequalities, sustainable commuting and transportation, responsible consumption, water conservation, and climate action.

Regarding the design of gamification, it is encouraging that previous research has developed a variety of different gamification designs, ranging from web and smartphone applications to serious games, simulations, board games, and campaigns. Similarly, most studies incorporate utilitarian, hedonic, as well as social aspects in the design of gamification, and thus consider all relevant aspects of user experience in motivational IS [249]. In this context, it can be noted that research on gamification for sustainable employee behavior has successfully moved beyond the PBL notion of gamification [222] to consider immersive elements such as storytelling, scenarios, and role-playing in the design of gamification. However, research is still deficient when it comes to the use of a variety of game elements that offer great potential for ongoing behavior change, such as unlockable content, motivational messages, and adaptive difficulty levels, an observation that is consistent with previous reviews of gamified applications for sustainable consumption [364]. Thus, future research is warranted that focuses on how such elements can support ongoing engagement in sustainable behaviors at work:

[249]: Hamari *et al.* (2015)

[222]: Schöbel *et al.* (2020)

[364]: Guillén *et al.* (2022)

**Agenda point 2:** Future research should focus on the design of gamification that potentially promote long-term engagement in sustainable behaviors at work, such as unlockable content, motivational messages, and adaptive difficulty.

Moreover, with respect to socially oriented design elements, studies have mostly focused on competitive or collaborative-competitive paradigms rather than collaborative designs. Given that previous research suggests that collective rather than individual efforts are required for sustainability in particular [365] and that collaborative approaches potentially outperform competitive designs in terms of user engagement [123] I call for future research specifically targeting collaborative gamification designs to support sustainable employee behavior:

[365]: Lozano (2007)

[123]: Morschheuser *et al.* (2018)

**Agenda point 3:** Future research should develop gamification approaches that focus on fostering interindividual collaboration rather than competition to achieve sustainable employee behavior.

Finally, from a methodological perspective, it becomes clear that few studies have examined the individual effects of various utilitarian, hedonic, and social design elements on psychological and behavioral outcomes. In particular, two studies have compared personalized versus non-personalized gamification designs [308], [311] and found that adaptive gamification performed better than one-size-fits-all designs. Yet, there is only one study on gamification for sustainable behavior [80] that draws on the research stream of personalized gamification and designs gamification in line with different motivations for sustainable behavior, based on Bartle's player types [350] and the Hexad typology [349]. Consequently, we still lack knowledge about the relative impact and effectiveness of different gamification design elements in promoting sustainable employee behavior and, specifically, how these impacts may differ across individuals:

[308]: Tuti *et al.* (2020)
[311]: Nuijten *et al.* (2022)

[80]: Kotsopoulos *et al.* (2017)

[350]: Bartle (1996)

[349]: Marczewski (2015)

**Agenda point 4:** Future research should examine the relative impact of different design elements in supporting sustainable employee behavior, with particular attention to interindividual differences among employees.

Regarding the theoretical lenses used in the studies to date, it is noteworthy that only a minority of the studies even consider theoretical foundations in their work, which reinforces the call for more theory-driven research [111] in the area of sustainable employee behavior as well. Of these, most rely on general motivational theories, such as SDT [261], flow theory [330], goal-setting theory [331], or the ARCS model [366], or behavioral theories, such as the TPB [166], Fogg's behavioral model [239], or the TTM [333]. In contrast, few studies draw on theoretical foundations specific to the topic of inquiry, such as the Health Belief Model [342] or the Health Action Process Approach [341] for health-related interventions [68], [305]. Although several studies focused on primarily instructional gamified interventions and examined knowledge and learning outcomes, they rarely base their designs on learning-related theories, such as social cognitive theory [329] and constructivist learning theory [338]. Therefore, future theory-driven re-

[111]: Nacke *et al.* (2017)

[261]: Ryan *et al.* (2017)

[330]: Csikszentmihalyi (1975)

[331]: Locke (1968)

[366]: Keller (1979)

[166]: Ajzen (1991)

[239]: Fogg (2009)

[333]: Prochaska *et al.* (1982)

[342]: Becker *et al.* (1974)

[341]: Schwarzer (1992)

[68]: Dadaczynski *et al.* (2017)
[305]: Brown *et al.* (2020)

[329]: Bandura (2001)

[338]: Vygotsky (1978)

search that draws on topic-specific and learning-related theories to design gamification for sustainable employee behavior is warranted:

**Agenda point 5:** Future research should shift away from focusing on general motivational and behavioral theories and draw on topic-specific and learning theories to advance theory-driven gamification design for sustainable employee behavior.

Furthermore, theoretical foundations are predominantly used to guide gamification design rather than evaluation, with the notable exception of Putz et al. [88], who examined the effects of gamification on behavioral determinants of the TPB, and the TAM, which, although not explicitly mentioned, likely guided scholarly interest in evaluating the utility and usability [118] of gamified interventions. In terms of psychological outcomes, while several studies have found positive hedonic and learning effects of gamification, little is known about how gamification supports the rational decision-making process toward sustainable behavior, i.e., the gain goal frame [133]. Furthermore, although six studies have observed positive effects on behavioral intention to change behavior [68], [84], [88], [315], [322], [325], there is still a lack of knowledge about how the various psychological outcomes related to hedonic, gain, and normative goal frames translate into behavioral intention. Therefore, the following avenue is suggested for future research:

[118]: Davis (1989)

[133]: Lindenberg *et al.* (2013)

[68]: Dadaczynski *et al.* (2017)
[84]: Oppong-Tawiah *et al.* (2020)
[88]: Putz *et al.* (2018)
[315]: Hart *et al.* (2020)
[322]: Shahrestani *et al.* (2017)
[325]: Suppan *et al.* (2021)

**Agenda point 6:** Future research should expand understanding of the psychological mechanisms of gamification for sustainable employee behavior by examining how different psychological outcomes related to hedonic, gain, and normative goal frames translate into behavioral intentions.

In addition, research efforts related to behavioral outcomes of gamification have largely focused on individual behavioral outcomes such as engagement and self-reported behavior change, while few studies have examined the social behavioral effects of gamification. While social behaviors do not appear to be directly related to sustainability outcomes, knowledge sharing [74], [77] and team dynamics such as group cohesion [73] in particular may be able to amplify social psychological determinants, e.g., relatedness [261] and subjective norm [166], which in turn increase employee engagement in the gamified sustainable behavior intervention. We still know little about how such social dynamics translate into corporate-level sustainability performance, and we still do not understand how such behaviors result from various psychological outcomes:

[74]: Agogué *et al.* (2015)
[77]: Patricio *et al.* (2022)

[73]: Cheng *et al.* (2022)

[261]: Ryan *et al.* (2017)

[166]: Ajzen (1991)

**Agenda point 7:** Future research should expand the understanding of pathways from gamification design to corporate-level outcomes by examining how psychological mechanisms induced by gamification lead to individual and, especially, social behaviors and how these play out at the corporate level.

Finally, it is noteworthy that few of the studies analyzed even examined corporate outcomes. While initial results point to great potential in the dimensions of energy conservation (SDG 7) [78], [79], [82], [84], [86] and

[78]: Hafer *et al.* (2017)
[79]: Kaselofsky *et al.* (2020)
[82]: Lou *et al.* (2019)

[86]: Iria *et al.* (2020)

[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[313]: Colabi *et al.* (2022)

innovation (SDG 9) [75], [76], [313], it is worthwhile to further explore the impact of gamification at the corporate level to more holistically assess the value of gamification interventions:

**Agenda point 8:** Future research should focus on the impact of gamification beyond the individual level and explore how gamification can influence corporate-level outcomes in various dimensions of sustainability.

## 4.6 Implications

The foregoing overview and discussion represent the first synthesis of the current state of knowledge on gamification for sustainable employee behavior in the workplace. It can be seen that empirical research has used different gamification designs and explored different psychological, behavioral, and corporate outcomes of gamification for sustainability in the workplace context. On the other hand, the discussion shows that there is still a lack of knowledge, both at the level of gamification design and at the level of pathways to sustainable employee behavior and corporate sustainability performance induced by gamification. The summary of existing knowledge and the developed research agenda provide valuable guidance for further research as well as for the practical design and use of gamification as an intervention to motivate sustainable employee behavior in the workplace environment.

### 4.6.1 Implications for Theory

By bringing together theories from gamification design and sustainability research, I developed a theoretical model to analyze and explain how gameful approaches lead to positive outcomes for sustainability at the psychological, behavioral, and corporate levels. Results show that while much research has focused on the design of gamification (RQ2) and whether gamified interventions can elicit positive psychological experiences (RQ3) and behavioral outcomes (RQ4), there is still a dearth of research on how motivating or enjoyable experiences translate into individual and social behavior change and the ways in which these behavioral outcomes support sustainability performance at the corporate level (RQ5). Therefore, future research is needed that explores the pathways of gamification to corporate sustainability.

Because the selection of design elements is rarely grounded in solid theoretical foundations (RQ1) and seldom analyzed individually, further theory-driven studies examining the relative influences of utilitarian, hedonic, and social elements in supporting positive psychological outcomes and subsequent behavioral outcomes are urgently needed. In this way, future research could also help explain why previous studies have reported mixed results on psychological experiences and behavioral outcomes related to sustainability in the workplace, and how gamification could be successfully designed to best support the process of behavior change toward sustainability.

Further, given that previous studies have focused heavily on hedonic and normative goal frames activated through gamification (RQ3), future research is required on how game design approaches, particularly utilitarian and social, can activate goal frames. By combining goal-framing theory [133] and the TPB [166] into the theoretical model, I believe to open new questions about how hedonic and normative goal-framing-related psychological experiences can influence behavioral intentions beyond the rational decision-making process, and future research is invited to explore their importance in behavior change processes for sustainability to inform future gamification design efforts.

[133]: Lindenberg *et al.* (2013)

[166]: Ajzen (1991)

### 4.6.2 Implications for Practice

Integrating the theoretical model of gamification for sustainable employee behavior with the results of the systematic review, I assume three potential design approaches for practice in designing gamification for sustainable employee behavior, summarized in Table 4.13.

First, the *cost-benefit approach* might be particularly appropriate when employees in a company tend to be primarily egoistically motivated to behave sustainably, i.e., they care mainly about the consequences for themselves and their children [160], and question the cost-benefit ratio of sustainable behavior in the workplace as opposed to other workplace duties and their own comfort, which is often the case because sustainable behavior is an additional duty for employees that conflicts with other goals [155]. This approach is about communicating the core message that sustainable behavior is beneficial to employees from a rational choice perspective. Consistent with this, the goal is to influence gain goal-related psychological outcomes [133], such as attitude, self-efficacy, and knowledge, and to draw on utilitarian and achievement-related hedonic design elements that support learning and self-efficacy. For example, companies might consider using informational content, direct feedback, goal setting, tips, or action planning in their interventions, coupled with badges, rewards, points, and levels or certificates. The introduction of sensor or system tracking, which automates the tracking of behavior change and thus reduces the effort required for employees to participate, is also a particularly suitable approach in this context. However, because elements to elicit extrinsic motivation in particular, such as rewards and badges, are used to influence the perceived cost-benefit ratio of sustainable behavior in the workplace in favor of sustainability, there may be potentially adverse effects on intrinsic motivation [367].

[160]: Stern *et al.* (1994)

[155]: Unsworth *et al.* (2013)

[367]: Deci *et al.* (1999)

Second, the *hedonic approach* can be best used when companies opt for short-term, topic-specific behavior change interventions. In this approach, the focus is on conveying the message that sustainable behavior is fun and appeals to hedonic goals [133]. Thus, the aim is to elicit hedonic psychological effects such as motivation, fun, enjoyment, and immersion in sustainable behavior. Several hedonic elements used in previous studies that promote immersion and curiosity could potentially be used in the hedonic approach, such as storytelling, unlockable content, scenarios, quizzes, and chance. Social elements that evoke a sense of playful challenge, such as inter-individual challenges, leaderboards, and trading, could also support hedonic enjoyment of sustainable behavior.

[133]: Lindenberg *et al.* (2013)

**Table 4.13:** Summary of suggested design approaches for gamification to support sustainable employee behavior.

| Design approach | Cost-benefit approach | Hedonic approach | Normative approach |
|---|---|---|---|
| Core message (based on goal-framing theory) | Sustainable behavior is beneficial | Sustainable behavior is fun | Sustainable behavior is the right thing to do |
| Focused psychological outcomes | Attitude towards sustainable behavior<br>Self-efficacy in behaving sustainably<br>Knowledge on sustainable behavior and behavioral consequences | Motivation to behave sustainably<br>Fun in sustainable behavior<br>Enjoyment in sustainable behavior<br>Immersion | Awareness of the need for sustainable behavior<br>Knowledge on sustainable behavior and behavioral consequences<br>Reflection on current behavior<br>Motivation to behave sustainably |
| Possible design elements | Focus on utilitarian elements for self-efficacy and achievement-related hedonic elements, e.g.<br>Informational content<br>Direct feedback<br>Goal-setting<br>Tips<br>Action planning<br>Sensor tracking<br>Badges<br>Rewards<br>Points<br>Levels<br>Certificates | Focus on hedonic elements that promote immersion and curiosity and social elements that evoke playful challenge, e.g.<br>Storytelling<br>Unlockable content<br>Scenarios<br>Quiz<br>Shuffling/chance<br>Challenge<br>Leaderboard<br>Trading | Focus on utilitarian elements for learning and social elements that exhibit social pressure, e.g.<br>Informational content<br>Instruction and instructional workshops<br>Self-evaluation<br>Suggestive questions<br>Teams<br>Social sharing<br>Forum |
| Particularly suitable if... | ... employees are primarily egoistically motivated to behave sustainably, are not yet very engaged in sustainable behavior, and question the cost-benefit ratio of sustainable behavior at work | ... sustainable behavior interventions should be implemented in short-term forms with a focus on a specific topic | ... there are strong relationships among employees and a corporate culture where we-intentions are deeply anchored |
| Potential pitfalls | Potentially undermining effects of extrinsic motivation on intrinsic motivation for sustainable behavior | Potential lack of translation into behavior change, particularly in learning-focused interventions<br>Potential novelty effect | Potentially negative effects on workplace atmosphere and colleague relationships |

It should be noted, however, that the hedonic approach, especially when based on full-fledged serious games with no direct connection to the work environment, may not translate learning outcomes into behavior change. Furthermore, hedonic elements may suffer from a novelty effect [48], [368] and lose their motivational impact over time, making this approach particularly suitable for the implementation of multiple topic-specific short-term interventions.

[48]: Koivisto *et al.* (2019)
[368]: Hamari (2013)

Third, the normative approach is best suited when strong relationships exist among employees and we-intentions are deeply embedded in the organizational culture, as the main message to be communicated is that sustainable behavior is the right thing to do, which works especially through learning and social pressure. Therefore, it is important to activate the psychological outcomes related to the normative goal frame [133], e.g., awareness, learning, reflection, and motivation, the latter especially by satisfying the need for relatedness [261]. To achieve this, organizations might draw on utilitarian and social elements that promote a combination of learning and social pressure. For example, design elements that have been used in previous studies include informational content, instruction and instructional workshops, self-evaluation and suggestive questions, and teams, social sharing, and forums. It is important to elevate sustainable behavior from an individual to a collective level to implement the normative approach. However, as studies show, a balance must be struck between healthy social pressure and potentially negative effects on workplace atmosphere and relationships with colleagues.

[133]: Lindenberg *et al.* (2013)

[261]: Ryan *et al.* (2017)

## 4.7 Conclusion and Limitations

In recent years, research on gamification has gained increasing attention as a potential tool to support sustainable employee behavior in the workplace. This systematic review, based on a theoretical model grounded in gamification design and sustainable employee behavior theory, has analyzed and discussed the design and psychological, behavioral, and corporate outcomes of previous studies on gamification for sustainable behavior in the workplace. In doing so, the findings point to exciting avenues for advancing future research in this area and lead to the identification of three practical approaches to designing gamification for sustainable employee behavior.

However, this study is not without limitations. Although the search terms were designed and tested to include all relevant studies on gamification for sustainable employee behavior, it is possible that some relevant studies that do not use one of the search terms in the title, abstract, or keywords were not included in this review. Because the focus of this study was primarily on examining the outcomes of gamification, both at the psychological, behavioral, and corporate levels, only empirical studies were included and design suggestions and proposals from a variety of conceptual studies on sustainability at work were disregarded. Future research should expand the review of design approaches to gamification in this context to include such conceptual studies, particularly to improve recommendations for practice in designing successful gamification.

While this work aimed to provide a critical analysis of the current state of academic knowledge on gamification for sustainable employee behavior, it neglected practitioner experiences that could also be considered valuable in understanding pathways to sustainable behavior in organizations. Further work is encouraged to expand the review with books, reports, and other sources from practitioners to incorporate practitioner perspectives into the theoretical model.

The preceding overview of gamification for sustainable employee behavior led to the following key insights for understanding the research problem as the basis for this research project:

- While previous research has focused on specific dimensions of sustainability at work, such as employee health and well-being, innovation, and energy conservation, there is a dearth of more holistic studies that address multiple dimensions of sustainable behavior with gamification
- In terms of gamification design, previous research has proposed and explored a range of utilitarian, hedonic, and social design elements, but it remains unclear how these elements influence psychological and behavioral outcomes
- There are many efforts to examine hedonic and normative goal frame-related psychological outcomes of gamification for sustainable employee behavior, but there is a paucity of studies exploring whether gamification can successfully influence rational decision-making processes as well
- Despite several positive individual and social behavioral outcomes of gamification for sustainable employee behavior, a lack of research exists on how gamification can translate such individual changes into measurable impacts on corporate sustainability

# Theoretical Knowledge Base

# 5 Study 2: Systematic Review on Theories in Gamification, Serious Games and Game-based Learning




**Publication of this study.**

The content of this study has been published in a similar form in [98] J. Krath, L. Schürmann, and H. F. O. von Korflesch, "Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning", Comput. Human Behav., vol. 125, p. 106963, Dec. 2021, doi: 10.1016/j.chb.2021.106963.


## 5.1 Context and Aim of this Study

The previous review on gamification for sustainable employee behavior underlines the potential of gamification to achieve desired psychological and behavioral outcomes. However, previous research shows that results are also sometimes ambiguous [50], [110], for instance concerning the effect of gamification on intrinsic or extrinsic motivation (e.g. [271], [272]) or enjoyment [48]. Gamification is thus not effective per se [369]. Rather, the design of effective gamified interventions requires theoretical knowledge of hitherto unexplored cognitive, emotional and motivational mechanisms through which gamification achieves its impact [48], [110] to successfully decide on appropriate structures, mechanics and principles [119].

[50]: Hamari *et al.* (2014)
[110]: Sailer *et al.* (2020)

[271]: Hanus *et al.* (2015)
[272]: Mekler *et al.* (2017)

[48]: Koivisto *et al.* (2019)
[369]: Sailer *et al.* (2017)
[119]: Dichev *et al.* (2017)

Scientific studies increasingly investigate the use of different theoretical foundations such as motivation, behavior, or learning theories to explain the effect of certain gamification elements or design gamification [111]. However, existing reviews on gamification, serious games and game-based learning, in which the scope is naturally determined by the application context and the focus of the review in terms of content, so far do not reflect the entire diverging theoretical landscape. Albeit, only a synthesis of the fragmented considerations from different disciplines leads to the depiction of the current state of theory in research and the identification of theoretical commonalities and basic principles that help explain how gamification works.

[111]: Nacke *et al.* (2017)

The gap of a comprehensive overview and analysis of theoretical foundations in gamification research requires a systematic investigation of the theories used to explain, design and evaluate gamification to guide the design and development of the artifact in the first DSR cycle. Consequently, this meta-review – a review of reviews in contrast to the analysis of primary research studies [121] – is the first to explicitly focus on the theoretical basis of gamification and aims *to identify the theoretical foundations used in primary studies mentioned in reviews on gamification, serious games and game-based learning both in general and in specific domains.* In addition, it aims to *compare and interlink the identified theoretical foundations to create an overview of the theoretical research landscape, discuss the common principles of how gamification works and open up avenues for further theory development.*

[121]: Gough *et al.* (2017)

Thus, starting from an observational perspective, the theories presented and their popularity in gamification research are reviewed, followed by a shift to an explanatory perspective, through which the relationships and commonalities of the identified theoretical foundations are analyzed. This ultimately leads to the derivation of basic theoretical principles from the underlying foundations that help explain the effects of gamification and support successful gamification design.

## 5.2 Theoretical Background

As presented in Chapter 3, considerable research efforts have already been made to investigate *whether* gamification leads to noticeable benefits, such as an increase in cognitive learning outcomes or work task performance, but there is still a lack of understanding regarding *how* gamification leads to these outcomes [111]. Using conceptual propositions as a basis, such as the foundations of game-based learning in which Plass, Homer and Kinzer argue that various affective, motivational, cognitive and sociocultural foundations, e.g. situated learning theory [370], [371], achievement goal theory [194], social cognitive theory [372] and activity theory [338] provide the basis for the successful design of game-based learning [258], scientific studies have recently begun to employ theoretical foundations to design, explain and evaluate their gamified interventions. However, existing reviews do not fully display the diversity of the theories applied in different contexts. For example, Seaborn and Fels [49] note the use of SDT [112], situational relevance theory [113] and the TTM [114] as prevalent foundations in primary gamification studies, whereas in contrast, Martí-Parreño et al. [373] mention cognitive load theory [116], the ARCS motivational model [117] and the TAM [118] as important theoretical foundations in gamification research. Dichev and Dicheva [119], on the other hand, review gamification in the educational context and emphasize Lander's theory of gamified learning [120] as an important theoretical treatise in scientific studies, which includes SDT [112], goal-setting theory [331], [374] and behavior reinforcement theory [375]. Thus, regarding the theoretical foundations of gamification, serious games and game-based learning, these results illustrate the controversy and lack of an overview of the theories that are used as a basis for scientific research on gamification in different contexts, and about their implications for explaining the way gamification achieves the observed positive results.

[111]: Nacke *et al.* (2017)

[370]: Brown *et al.* (1989)
[371]: Lave *et al.* (1991)

[194]: Elliot *et al.* (2001)

[372]: Bandura (1986)

[338]: Vygotsky (1978)

[258]: Plass *et al.* (2015)

[49]: Seaborn *et al.* (2015)

[112]: Ryan *et al.* (2000)

[113]: Wilson (1973)

[114]: Prochaska *et al.* (1997)

[373]: Martí-Parreño *et al.* (2018)

[116]: Sweller (1988)

[117]: Keller (1987)

[118]: Davis (1989)

[119]: Dichev *et al.* (2017)

[120]: Landers (2014)

[331]: Locke (1968)
[374]: Locke *et al.* (2002)

[375]: Skinner (1953)

In addition, there is a scarcity of research to explain certain mixed and conflicting results regarding the effects of game elements on motivational and affective, behavioral, and learning outcomes (e.g. [50], [110], [272], [273]). For example, some studies display ambiguous results regarding effects on the focus group (e.g. [376]) or the influence of specific gamification mechanics (e.g. [377]). Accordingly, gamification does not seem to be a *"silver-bullet type of solution"* for achieving positive outcomes [48, p. 201], and is not effective per se [369]. It is all the more important to understand the factors contributing to successful gamification, because in spite of the increasing adoption of theoretical foundations in research, they remain unresolved [110]. Insufficient knowledge about the psychological mechanisms through which gamification, serious games and game-based learning produce their effects [48], [110], [378] hampers the selection of appropriate gamification structures, mechanics and principles to obtain the desired outcomes [119]. Although more recently, advances in explaining the impacts of certain gamification elements and designing gamification through the use of different theories have been made [111], further research synthesizing the principle assumptions of the theoretical foundations in use is crucial to understand how gamification, serious games and game-based learning can be designed in diverse contexts [110], [119].

[50]: Hamari *et al.* (2014)
[110]: Sailer *et al.* (2020)
[272]: Mekler *et al.* (2017)
[273]: Zimmerling *et al.* (2019)

[376]: Hanghøj *et al.* (2018)

[377]: Facey-Shaw *et al.* (2020)

[48]: Koivisto *et al.* (2019)

[369]: Sailer *et al.* (2017)

[378]: Cheng *et al.* (2015)

[111]: Nacke *et al.* (2017)

Therefore, this paper aims at answering the questions which theories have so far been used as foundations in research on gamification, serious games and game-based learning, how they relate to each other through core assumptions, and which basic principles can be derived that help explain how gamification achieves its effects.

## 5.3 Research Method

Systematic reviews give a methodical, replicable, and transparent overview over the complex field of literature to topics such as gamification. They provide an overall impression of the extent, nature and quality of evidence regarding the research question in focus. Thereby, they help to draw robust and broad implications for theory and future research [379]. Meta-reviews, also called umbrella reviews, are reviews of existing reviews [121] and represent an appropriate methodological choice when there are already a large number of systematic reviews addressing the same or a very similar research question, with a concomitant increase in discordant findings [106]. As explained, this is the case for existing reviews on theoretical foundations in gamification, serious games, and game-based learning. Specifically, the goal of a meta-review is to assemble the results of qualitative studies on a topic to locate core concepts or theories that provide new or stronger explanations for a particular phenomenon [122] and to compile the available evidence on a specific research focus into a summary [106]. Hence, the method of a systematic meta-review was identified as appropriate to answer the following primary research question by synthesizing the results of existing systematic literature reviews:

[379]: Siddaway *et al.* (2019)

[121]: Gough *et al.* (2017)

[106]: Paré *et al.* (2015)

[122]: Thorne *et al.* (2004)

**Research question:** *What are theoretical foundations used in research on gamification, serious games and game-based learning?*

The review is conducted according to the ROSES standard, which advances the widely recognized PRISMA standard for meta-analyses from medical research [108], that focuses merely on quantitative data syntheses, into a new standard for narrative, qualitative and mixed methods syntheses [107].

[108]: Moher *et al.* (2009)

[107]: Haddaway *et al.* (2018)

**Search strategy.** For the identification of relevant literature, nine scientific databases were searched, namely the Web of Science Core Collection, EBSCO Host (APA PsychArticles, APA PsychInfo, Business Source Premier), Wiley Online, EmeraldInsight, ScienceDirect, JSTOR, SagePub, IEEE Explore and Taylor & Francis. The following search string was employed to gather review studies on gamification, serious games or game-based learning either in general or related to specific outcomes, i.e. affect, motivation, behavior or learning:

**Search string:** *TITLE-ABS-KEY(((”Gamification” OR ”Serious Gaming” OR ”Serious Games” OR “Game-based learning”) AND ((motivation* AND ”theories”) OR (behavior* AND ”theories”) OR (learning* AND “theories”) OR (affect* AND “theories”) OR ”theoretical foundations” OR ”theoretical perspectives” OR ”theoretical frameworks” OR ”theoretical approaches” OR (systematic* AND ”review”) OR ”meta-analysis”)) OR ”Gamification theories”)*

Table 5.1: Inclusion and exclusion criteria for the review on theoretical foundations in gamification research.

| Criterion | Included | Excluded |
|---|---|---|
| Language | English | Other languages, e.g. Spanish, German, Russian, Korean, Chinese, Japanese |
| Publication type | Peer-reviewed journals, peer-reviewed conference papers | Book chapters, magazine articles, reports, these, other grey literature |
| Type of study | Systematic literature review, mixed methods study containing a systematic literature review | Empirical studies, reviews of practical gamified applications or software |
| Study topic | Gamification, serious games, game-based learning | Video games |
| Study content | Examination of theoretical foundations used in the review sample | Theoretical foundations only mentioned in the introduction or background or not mentioned at all |

The pluralistic version of "theory", "perspective", "framework" and "approach" has been used to exclude articles that mention only a single theoretical basis of their own work (e.g., a review of outcomes in game-based learning from a SDT perspective) and to focus on review studies that systematically analyze theoretical underpinnings of multiple papers, since the main goal is to provide a comprehensive overview of the use of different theoretical foundations in scientific research. The search string was employed for title, abstract, and author keyword search, considering all articles published up to April 2021.

**Screening strategy and inclusion criteria.** According to the ROSES standard [107], the screening was carried out in three steps: Title screening, abstract screening, and full-text screening. To ensure research quality, only peer-reviewed journal articles and peer-reviewed conference papers were included in the final sample, while book chapters, not peer-reviewed journal articles and other gray literature were excluded. The reasons why conference papers were considered are that they account for a significant proportion of citations in computer science and research on human-computer interaction [296] and that the identification of articles from conference proceedings is generally recognized as good practice in systematic reviews [297]. Only English articles were included. Furthermore, the studies were included if they consisted of a systematic review or if they were a mixed-method study that contained a systematic review of scientific literature on gamification, serious gaming, or game-based learning, in which the theoretical foundations used in the reviewed sample were examined. Accordingly, empirical studies only referring to their own approach, reviews focusing on practical gamified applications such as smartphone apps or games, reviews on video games, and reviews only mentioning theories in their introduction or background but not examining the theoretical foundations of their sample studies or completely disregarding the theoretical perspective, were excluded during the screening process. The inclusion and exclusion criteria for the article screening are summarized in Table 5.1.

[107]: Haddaway *et al.* (2018)

[296]: Michels *et al.* (2014)

[297]: Scherer *et al.* (2019)

**Critical appraisal strategy.** For the critical appraisal of the reviewed studies, the following criteria were checked for each individual study:

1. Did the authors formulate at least one clear research question or research goal?
2. Did the authors describe their method for the systematic review?

a) search string(s)
b) search results
c) inclusion and exclusion criteria
d) number of included studies

3. Did the authors answer their research question(s)/goal(s) properly?

Secondly, the publications were checked for their CORE journal rank, their Scientific Journal Ranking (SJR) and their Journal Impact Factor (JIF) to critically appraise the quality of the entire review sample.

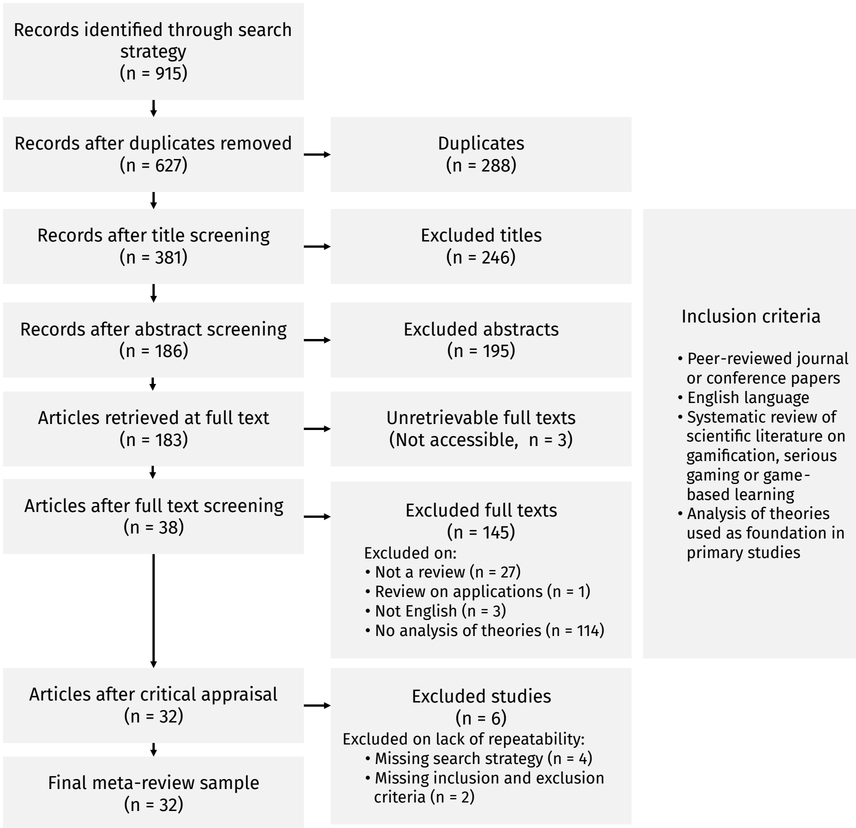


Figure 5.1: Flow diagram for the selection of studies in the systematic review on theoretical foundations in gamification research.

Figure 5.1 illustrates the result of the search strategy and the screening process. By applying the search string to the scientific databases, 973 records were identified, of which 915 remained through filtering for peer-reviewed articles and conference papers. After the duplicate removal, 627 records remained for screening. Of this sample, 246 records were excluded after the title screening, 195 records after the abstract screening and three full texts could not be retrieved so that 183 articles were considered for the full-text screening. During the full-text screening, 145 articles were excluded because they did not meet the specified inclusion criteria. This resulted in 38 articles remaining for critical appraisal, of which six articles were discarded due to lack of repeatability, as they either did not describe their literature search strategy (four studies) or lacked a definition of the inclusion and exclusion criteria (two studies). For reasons of reproducibility, the entire list of excluded full texts is attached in Section B.1. In summary, 32 reviews remained for data extraction and synthesis.

**Data extraction strategy.** Metadata such as title, year of publication, authors, publication type (journal or conference proceedings) and publication name of the articles were extracted with Mendeley Reference Manager and manually checked upon import. In addition, qualitative data extraction involved inductively encoding the application context of the review, the theoretical foundations mentioned in the review using abbreviations (the full coding list of abbreviations is attached in Section B.2) and summing up the number of studies applying a particular theoretical foundation, provided that the total number was given by the analyzed review. Although five of the reviews did not note the number of studies employing a particular theory, the popularity of different theoretical foundations could be assessed based on the available data, so that the missing data was not explicitly obtained from the review authors. Furthermore, a coding scheme for the classification of the identified theoretical foundations was developed based on the three main outcomes of gamification, i.e. affect and motivation, behavior and learning (attached in Section B.3), inspired by the distinction of previous reviews, the categorization of Plass et al. [258] and Bloom's taxonomy [266].

[258]: Plass *et al.* (2015)

[266]: Bloom (1956)

## 5.4 Results

I first narratively report on the quality of the reviewed sample, the years of publication, the topics, and the application contexts of the reviewed articles, followed by the qualitative analysis of theoretical foundations mentioned in research on gamification, serious games and game-based learning.

### 5.4.1 Sample Quality, Topics, and Application Contexts

In critical appraisal of the sample's quality, it can be stated that all the reviews included were published in peer-reviewed journals, most of which are ranked highly in the Scientific Journal Ranking (SJR) and Journal Impact Factor (JIF). 18 of 32 reviews were published in the first quartile of their respective research area, mostly human-computer interaction, computer science, pedagogy, and psychology.

The first review explicitly mentioning theoretical foundations used in studies on serious games appeared in 2013 [380]. Since then, the number of reviews analyzing the use of theory in empirical research demonstrates continuous scientific interest in the field of gamification, serious gaming, and game-based learning, with 12 of 32 reviews published in 2020 and 2021. Most of the reviews either focus on game-based learning or gamification in the application context of education (16 reviews). The second topic focus (8 reviews) consists of reviews on serious games, gamification and game-based learning in healthcare and fitness, followed by seven reviews on gamification, serious games and game-based learning in general, without a specific use case. In addition, one review dealt with gamification and online consumer decisions.

[380]: Li *et al.* (2013)

### 5.4.2 Theoretical Foundations in Research on Gamification, Serious Games and Game-based Learning

This meta-review shows that empirical studies on gamification, serious games and game-based learning have so far used a variety of 118 different theories. Some theoretical foundations are considerably more popular than others, of which the most popular one (SDT) is used in 82 different studies and the least popular ones are applied to only one study to date. Table 5.2 outlines all the theories mentioned in the analyzed reviews, together with the total number of primary research studies conducted based on each theory.

The theoretical foundations used originate from various theoretical research streams, including cognitive psychology, social psychology, and human-computer interaction. In the following, the identified theories are described and elaborated regarding their use in research on gamification, serious games and game-based learning. For further interest in the theoretical foundations, additional explanations of the theories and their origins are provided in Section B.4.

### Theoretical Foundations with a Focus on Affect and Motivation

The first set of foundations focusing on affect and motivation is mainly concerned with *motivation* and *valence*, while arousal was not addressed in the identified theories.

Theories focusing on motivation deal with the mechanisms and determinants of motivation formation, such as the basic psychological needs – autonomy, competence and relatedness – from SDT [261] or self-efficacy, which describes a person's belief that they can successfully perform the required behavior [352]. Studies conclude that game mechanics partially [381], [382] or fully [383] address the basic needs for autonomy, competence and relatedness through elements such as customization which promote feelings of autonomy [384], achievements and badges that foster feelings of competence [385] or teams and social networks that enhance feelings of relatedness [383]. Gamification and serious games also increase self-efficacy, e.g., for reacting in emergencies [386], identifying cyber-security threads [387] and performing learning tasks [388]. Related to self-efficacy theory, social comparison theory emphasizes the natural urge to assess oneself in comparison with others [389], which can be perceived as motivating or discouraging depending on circumstances [390]. For example, social comparisons in form of leaderboards or social status elements can have different effects in different samples [391].

[261]: Ryan *et al.* (2017)
[352]: Bandura (1982)
[381]: Frost *et al.* (2015)
[382]: Roy *et al.* (2019)
[383]: Xi *et al.* (2019)
[384]: Kim *et al.* (2015)
[385]: Peng *et al.* (2012)
[386]: Chittaro *et al.* (2019)
[387]: Baral *et al.* (2019)
[388]: Blasko-Drabik *et al.* (2013)
[389]: Festinger (1954)
[390]: Buunk *et al.* (2007)
[391]: Christy *et al.* (2014)

Flow theory presents flow as a *"holistic sensation that people feel when they act with total involvement"* [330, p. 36]. Although flow is inherently valent, it is closely related to motivation: when individuals are fully engaged in an activity, they experience the activity as intrinsically rewarding and pursue it for the sake of the activity itself rather than to achieve the ultimate goal [392]. However, the impact of gamification and serious games on flow experiences has not yet been clearly established [393]–[396].

[330]: Csikszentmihalyi (1975)
[392]: Csikszentmihalyi (2014)
[393]: Almeida *et al.* (2019)
[394]: Bitrián *et al.* (2020)
[395]: Catalán *et al.* (2019)
[396]: Chung *et al.* (2019)

Other theories address both motivation and valence, describing the effect of predictors such as expectations and values, as included in the ARCS model of motivation for instructional design, which states that motivation is the result of a combination of four factors – attention, relevance, confidence and satisfaction [117], [397].

[117]: Keller (1987)
[397]: Porter *et al.* (1968)

Table 5.2: Theoretical foundations mentioned in the analyzed review studies.

| Theoretical foundation | Reviews mentioning theory | Sum of studies using theory |
|---|---|---|
| Self-determination theory | [49], [119], [223], [224], [250], [277], [278], [281], [398]–[406] | 82 |
| Flow theory | [223], [224], [237], [250], [277], [278], [281], [378], [398], [399], [402]–[404], [407], [408] | 47 |
| Experiential learning theory | [237], [279], [380], [398], [407]–[410] | 40 |
| Constructivist learning theory | [224], [237], [262], [270], [278], [378], [380], [408] | 31 |
| Cognitive load theory | [115], [224], [277], [378], [380], [398], [399], [403] | 24 |
| Social cognitive theory | [380], [399], [401], [403], [405], [409], [411], [412] | 16 |
| Situated learning theory | [237], [378], [380], [398], [407], [408], [410] | 29 |
| Sociocultural theory of cognitive development | [224], [270], [378], [380], [398], [407], [410] | 23 |
| Technology acceptance model | [115], [223], [250], [262], [275], [399], [405] | 13 |
| Theory of planned behavior | [223], [277], [399], [401], [402], [405], [411] | 10 |
| Reinforcement theory | [119], [224], [262], [270], [279], [405] | 9 |
| Social learning theory | [399], [405], [408]–[410], [412] | 8 |
| ARCS model | [115], [262], [275], [399], [403] | 14 |
| Transtheoretical model of behavior change | [49], [399], [401], [405] | 19 |
| Activity theory | [237], [378], [380], [410] | 14 |
| Goal-setting theory | [119], [224], [404], [405] | 10 |
| Theory of reasoned action | [224], [399], [401], [405] | 6 |
| Problem-based learning[a] | [380], [398], [410] | 29 |
| Multimedia learning theory | [378], [380], [404] | 10 |
| Achievement goal theory | [277], [403], [413] | 5 |
| Self-efficacy theory | [224], [399], [400] | 4 |
| Social comparison theory | [223], [224], [279] | 4 |
| Discovery learning theory | [398], [410] | 16 |
| Case-based learning[b] | [398], [410] | 12 |
| Mechanics, dynamics and aesthetics framework | [250], [399] | 11 |
| Stage theory of cognitive development | [398], [410] | 10 |
| Digital game-based learning[c] | [399], [407] | 6 |
| User-centered design[d] | [49], [250] | 4 |

[a] Problem-based learning is not a theory, but a specific paradigm of instructional design related to constructivist learning. It is therefore excluded in the further analysis.

[b] Case-based learning is not a theory, but a specific paradigm of instructional design related to constructivist learning. It is therefore excluded in the further analysis.

[c] Bozkurt and Durak [399] note digital game-based learning as a theoretical foundation, but the term describes a whole research field within gamification and serious gaming rather than a specific theory, so it is excluded in the further analysis.

[d] User-centered design is not a theory, but much more a paradigm of tailoring the design process around the user's needs and expectations. It is therefore excluded in the further analysis.

Table 5.2: Theoretical foundations mentioned in the analyzed review studies (continued).

| Theoretical foundation | Reviews mentioning theory | Sum of studies using theory |
|---|---|---|
| Cognitive evaluation theory | [224], [399] | 4 |
| Uses and gratifications theory | [237], [277] | 4 |
| Gangé's instruction strategies[e] | [406], [410] | 4 |
| Fogg's behavior model | [224], [399] | 3 |
| Theory of motivation, volition and performance | [262], [275] | 3 |
| Situational relevance theory | [49], [250] | 2 |
| Theory of multiple intelligence | [380], [407] | 2 |
| Immersion theory | [403], [407] | 2 |
| Transportation theory | [406], [411] | 1 |
| Lander's theory of gamified learning | [224], [402] | 1 |
| Health belief model | [405], [411] | 1 |
| Direct instruction[f] | [410] | 9 |
| Elaboration theory | [410] | 7 |
| User-centered theoretical framework for meaningful gamification | [399] | 4 |
| Constructionism | [237] | 4 |
| Cognitive apprenticeship | [410] | 4 |
| Inquiry-based learning[g] | [407] | 4 |
| Programmed instruction[h] | [410] | 3 |
| Social conformity theory[i] | [405] | 3 |
| Information, motivation and behavior model | [409] | 3 |
| Interest theory of learning | [380] | 2 |
| Theory-driven gamification design model | [224] | 2 |
| Unified theory of acceptance and use of technology | [405] | 2 |
| Malone's theory | [262] | 2 |
| Taxonomy of behavior change techniques | [406] | 2 |
| Maslow's hierarchy of needs | [399] | 2 |
| Diffusion of innovation theory | [399] | 2 |
| Theory of organizational behavior | [399] | 2 |
| Situational interest theory | [400] | 2 |
| Mood management theory | [277] | 2 |
| Communication theory | [277] | 2 |
| Theory of affordances | [278] | 2 |
| Guilford's structure of intellect | [278] | 2 |

[e] Gagnés instruction strategies or principles are not a theory, but guidelines for instructional design. They are therefore excluded in the further analysis.

[f] Direct instruction is not a theory, but a specific instructional method related to behaviorism. It is therefore excluded in the further analysis.

[g] Inquiry-based learning is not a theory, but a specific paradigm of instructional design. It is therefore excluded in the further analysis.

[h] Programmed instruction is not a theory, but a specific instructional method related to behaviorism. It is therefore excluded in the further analysis.

[i] Orji and Moffatt [405] claim that social conformity theory was used in three of the studies they analyzed, but further investigation revealed that the studies cited only used the concept of the importance of social influence and pressure in designing their interventions, rather than referring to a specific theoretical foundation, model or framework. Since subsequent searches did not reveal gamification or serious gaming studies using such a theory, it is excluded in the further analysis.

Table 5.2: Theoretical foundations mentioned in the analyzed review studies (continued).

| Theoretical foundation | Reviews mentioning theory | Sum of studies using theory |
|---|---|---|
| Model model | [278] | 2 |
| Moran's theorem | [278] | 2 |
| Attribution theory | [410] | 2 |
| Actor-network theory | [410] | 1 |
| Wisdom, intelligence and creativity synthesized theory | [278] | 1 |
| Play, affect and creativity theory | [278] | 1 |
| Self-directed learning theory | [279] | 1 |
| Expectancy-value theory | [119] | 1 |
| Theory of gamified instructional design | [119] | 1 |
| Ego depletion theory | [405] | 1 |
| Parallel process model | [405] | 1 |
| Theory of meanings of behavior | [405] | 1 |
| Knowledge, attitude, behavior model | [405] | 1 |
| Premack's principle | [405] | 1 |
| Big five personality theory | [405] | 1 |
| Sexual health model | [405] | 1 |
| Narrative centered learning[j] | [237] | 1 |
| Deliberate practice[k] | [279] | 1 |
| Social network theory | [401] | 1 |
| Theory of interactive technology | [401] | 1 |
| Transcontextual model of motivation | [401] | 1 |
| Control theory | [401] | 1 |
| Information systems success model | [224] | 1 |
| Presence pedagogy model | [224] | 1 |
| Eisenkraft's 7E instructional model | [224] | 1 |
| Felder-Silverman learning style model | [224] | 1 |
| Merrill's principles of instruction design theory | [224] | 1 |
| Technology-enhanced training effectiveness model | [224] | 1 |
| Unified modeling language[l] | [224] | 1 |
| Rational choice theory | [224] | 1 |
| Mechanics, dynamics and emotions model | [250] | 1 |
| Moral design framework | [250] | 1 |
| Organismic integration theory | [250] | 1 |

[j] Narrative-centered learning is not a theory for itself, but the realization of instruction strategies grounded in transportation theory. It is therefore excluded in the further analysis.

[k] Deliberate practice describes a paradigm of learning with purposeful repetition, but it is not a learning theory. Therefore, it is excluded in further analysis.

[l] The Unified Modeling Language is not a theoretical foundation. It was mentioned by Zainuddin et al. [224] because it was used in the original study as the teaching content of their gamified intervention and is listed here for the sake of completeness but excluded in the further analysis.

Table 5.3: Theoretical foundations mentioned in the analyzed review studies (continued).

| Theoretical foundation | Reviews mentioning theory | Sum of studies using theory |
|---|---|---|
| Four drives theory | [250] | 1 |
| Person-artefact-task model | [250] | 1 |
| Affect transfer theory | [277] | 1 |
| Cognitive dissonance theory | [277] | 1 |
| Middle-range theory of chronic illness | [409] | 1 |
| Adult learning theory | [409] | 1 |
| Murray's secondary psychological needs | [413] | 1 |
| Situative embodiment[m] | [380] | 1 |
| Transformational play[n] | [380] | 1 |
| Prediction-observation-explanation model | [380] | 1 |
| Enactivism | [380] | 1 |
| Behavioral economics[o] | [406] | 1 |
| Dual-task training[p] | [406] | 1 |
| Tripartite enjoyment model | [403] | 1 |
| Universal design for learning | [49] | 1 |
| Scientific discovery as dual search model | [237] | 1 |
| Gee's game-based learning principles[q] | [407] | 1 |
| Werbach's gamification framework | [407] | 1 |
| Embodied learning[r] | [407] | 1 |
| Taxonomy of intrinsic motivations for learning | [407] | 1 |
| Theory of realistic mathematics education | [407] | 1 |
| Theory of motivation to learn[s] | [404] | 1 |
| Elaboration likelihood model | [411] | - |
| Taxation theory | [224] | - |

[m] Situative embodiment is a central concept in the phenomenological school of thought, but not a specific theory. Therefore, it is excluded in further analysis.
[n] Transformational play is a form of play to promote creativity, innovation, empowerment and social connection, but it is not a theory and therefore excluded in further analysis.
[o] [15]Behavioral economics is a specific discipline within economic science and includes a variety of different theories, such as prospect theory and nudge theory. However, Thomas et al. [406] did not specify the theory used in the primary study, and further investigation of the primary study did not lead to the identification of a specific theory either. Therefore, behavioral economics is excluded in the further analysis.
[p] Dual-task training is not a theory, but a training method. It is therefore excluded in the further analysis.
[q] Gee's game-based learning principles are useful for the design of game-based learning, but they rather constitute recommendations than theory. Therefore, they are excluded in the further analysis.
[r] Embodied learning is not a theory, but a specific instructional method. It is therefore excluded in the further analysis.
[s] The theory of motivation to learn was mentioned as a theoretical foundation in the review of Kalogiannakis et al. [404], but they do not mention the specific primary study using this foundation. As a detailed search could not identify such a theory, it is excluded in the further analysis.

[366]: Keller (1979)
[331]: Locke (1968)
[414]: Nicholls (1984)
[358]: Locke *et al.* (2013)
[374]: Locke *et al.* (2002)
[415]: Calvo-Ferrer (2018)
[416]: Deif (2017)
[417]: Kaneko *et al.* (2015)
[418]: Ozdamli (2018)

Satisfaction as a valent determinant of motivation depends on outcome expectations, such as goals, while confidence refers to personal belief in success, i.e., self-efficacy [366]. Similarly, goal-setting theory [331] and achievement goal theory [414] emphasize the importance of goals for motivational mechanisms and the importance of satisfaction with goal achievement for commitment to further goals [358], [374]. While the ARCS questionnaire is often used to quantitatively evaluate the motivational effect of serious games and game-based learning on the four factors, with positive to mixed results (e. g. [415]–[418]), possibly due to its pedagogical focus, the latter, i.e. goal-setting and achievement goal theory, are used predominantly to refine and improve gamified interventions, e.g. with leaderboards as goal-setting mechanisms (e. g. [419]–[421]), and the individualization to achievement goal orientations with various game elements such as feedback, progress bars, leaderboards and badges (e. g. [422]).

[419]: Chernbumroong *et al.* (2017)
[420]: Landers *et al.* (2017)
[421]: Nebel *et al.* (2017)

[422]: Roosta *et al.* (2016)

### Theoretical Foundations with a Focus on Behavior

Second, there are a variety of theoretical foundations that describe the determinants of *behavioral* outcomes. Reinforcement theory, the most prominent example of radical behaviorism [423], considers the cognitive processes of behavior formation as a *"black box"* and suggests direct relationships between stimuli and outcomes [375]. It primarily guides the study of whether extrinsic gamification mechanics, such as rewards [270], [424] or climbing the leaderboard [425], can positively influence learning outcomes.

[423]: Moore (2011)

[375]: Skinner (1953)

[270]: Kordaki *et al.* (2017)
[424]: Berkovsky *et al.* (2012)

[425]: Huang *et al.* (2019)

Other theories focusing on behavior, such as the TRA [164], the TPB [166] and the TAM [118], outline the importance of behavioral attitudes and subjective norms on behavioral intention, which then leads to actual behavior. In addition, as an extension of the TRA, the TPB adds perceived behavioral control as a determinant of behavioral intention [166], which is closely related to the motivational concept of self-efficacy [426], while as a second extension of the TRA tailored to user acceptance of information systems, the TPB adds perceived usefulness and perceived ease of use as determinants of behavioral attitude [118]. All three theories serve as a basis to assess the impact of gamification on the determinants (behavioral attitude, subjective norms and perceived behavioral control) and thus on behavioral intentions, such as the intention to adopt solar energy [427], choose sustainable means of transport [56], or make a purchase [428]. In the case of the TAM, the framework is also used to evaluate the acceptance of gamified interventions, e.g., whether they perform well in terms of perceived usefulness and perceived ease of use, thereby generating positive attitudes and behavioral intent to use (e. g. [429]–[431]).

[164]: Ajzen *et al.* (1980)

[166]: Ajzen (1991)

[118]: Davis (1989)

[426]: Ajzen (2002)

[427]: Rai *et al.* (2017)

[56]: Andersson *et al.* (2018)

[428]: Bittner *et al.* (2014)

[429]: Bourgonjon *et al.* (2013)
[430]: Siala *et al.* (2019)
[431]: Vanduhe *et al.* (2020)

Furthermore, two theories describe the process of behavior change [333] and the cognitive system in which human actions are influenced by rules, culture and the community, called the activity system [290], [338]. These theories are not used for evaluation, but for the design of gamified systems and serious games. They are either based on the stages of the TTM to promote changes towards healthy behavior [432], [433] and sustainable behavior [56], [434], e.g., by focusing on the provision of information in the early stages and shifting to elements of social pressure and performance tracking mechanisms in the later stages [56], [434], or based on the activity system with the game as a mediating instrument (e. g. [435]–[439]).

[333]: Prochaska *et al.* (1982)

[290]: Engeström (2015)
[338]: Vygotsky (1978)

[432]: Alsaleh *et al.* (2020)
[433]: Bahia *et al.* (2014)

[434]: AlSkaif *et al.* (2018)

[435]: Calvo *et al.* (2018)
[436]: Carron *et al.* (2008)
[437]: Charrouf *et al.* (2019)
[438]: De Freitas *et al.* (2006)
[439]: Ellahi *et al.* (2017)

### Theoretical Foundations with a Focus on Learning

The third category of theoretical foundations deals with determinants and processes of *learning*. Most of these theories originate from social psychology, e.g. social learning theory [440], social cognitive theory [441], and the sociocultural theory of cognitive development [338], and describe the crucial role of sociocultural influences and interactions in successful learning processes. A central concept in social learning theory and social

[440]: Bandura (1971)

[441]: Bandura (2001)

cognitive theory, which is an extension of social learning theory, is that of *vicarious learning*, that is, learning by observing others [440]. This concept guides the design of game-based learning interventions, e.g. by introducing mechanisms that enable social observation processes [442] or by designing role model game characters [443] for vicarious learning [444]–[446]. In turn, sociocultural theory of cognitive development introduces the idea of the *Zone of Proximal Development*, i.e., the distance between the actual level of development and the level of potential development that can be acquired through guidance, peer cooperation, or instruction [338]. Gamification and serious games based on sociocultural theory are adaptive and individualized in design to scaffold the learners within their zones of proximal development (e.g. [447], [448]).

[440]: Bandura (1971)
[442]: Jeen *et al.* (2007)
[443]: Fuchslocher *et al.* (2011)
[444]: Amresh *et al.* (2019)
[445]: Bowen *et al.* (2014)
[446]: Bul *et al.* (2015)
[338]: Vygotsky (1978)
[447]: Davis *et al.* (2018)
[448]: Rachels *et al.* (2018)

Constructivist learning theory [339], [449] addresses the general process of knowledge construction and the initialization of learning processes, incorporating motivational aspects as crucial preconditions for successful learning. On this basis, the inclusion of constructivist principles in gamified applications such as experiential learning, participation and self-reflection (e. g. [270], [450], [451]) aims to improve desired learning outcomes. In this context, experiential learning theory emphasizes that knowledge is acquired through personal and environmental experiences rather than through instruction and in an iterative learning cycle [452]. Relatedly, situated learning theory states that conceptual knowledge cannot be abstracted from the situations in which it is learned and used [370]. Hence, learning environments need to be designed in such an authentic way that students can learn by linking their prior knowledge to real-world scenarios as they participate in the learning activities [453]. Accordingly, both experiential learning theory and situated learning theory guide the design of virtual environments in serious games to resemble real-world environments and problem-solving contexts (e.g. [454]–[456]) to allow for experience, observation and experimentation (e.g. [457]–[459]).

[339]: Jonassen (1999)
[449]: Piaget (1977)
[270]: Kordaki *et al.* (2017)
[450]: Avramenko (2012)
[451]: Huebscher *et al.* (2010)
[452]: Kolb (1984)
[370]: Brown *et al.* (1989)
[453]: Hwang *et al.* (2015)
[454]: All *et al.* (2017)
[455]: Hou (2015)
[456]: Hou *et al.* (2014)
[457]: Furió *et al.* (2013)
[458]: Verkuyl *et al.* (2017)
[459]: Wrzesien *et al.* (2010)

Finally, cognitive load theory [116] and multimedia learning theory [460] are concerned with mental processing capacity and the different mental processes involved in organizing and linking learning content to prior knowledge. Extraneous processing or extraneous cognitive load in this context represent cognitive processes that distract from active processing of learning content [116], [460]. Both theoretical bases open up scientific discussions on whether serious games, game-based learning and gamification can be designed to reduce the extraneous cognitive load or if they increase cognitive load and thus cause counterproductive effects on learning (e.g. [15], [461]–[464]).

[116]: Sweller (1988)
[460]: Mayer (2005)
[15]: Adams *et al.* (2014)
[461]: Brom *et al.* (2019)
[462]: Deleeuw *et al.* (2011)
[463]: Johnson *et al.* (2010)
[464]: Moreno *et al.* (2005)

### Other Theoretical Foundations

Scientists have used a variety of other theoretical foundations of secondary importance, i.e., they were only mentioned by one or two reviews, from different disciplines. Some of them aim to propose guidelines for system design, such as the MDA [254], the user-centered theoretical framework for meaningful gamification [345], or Werbach's gamification framework [244]. They are used for gamification design in a variety of scientific studies (e. g. [465]–[469]). In addition, the theoretical foundations originate from management research, such as theories of organizational behavior (e. g. [470]) or the DOI [214], but also medicine (Sexual Health Model; [471]) and

[254]: Hunicke *et al.* (2004)
[345]: Nicholson (2012)
[244]: Werbach (2014)
[465]: Angelia *et al.* (2019)
[466]: Arnab *et al.* (2017)
[467]: Constantinescu *et al.* (2017)
[468]: Dietrich *et al.* (2018)
[469]: Stansbury *et al.* (2017)
[470]: Mayo (1933)
[214]: Rogers (2003)
[471]: Robinson (2015)

Table 5.4: Prevalent theoretical foundations in research on gamification, serious games and game-based learning (mentioned at least three times).

| Affect & Motivation | Behavior | Learning |
|---|---|---|
| Self-determination theory | Technology acceptance model | Experiential learning theory |
| Flow theory | Theory of planned behavior | Constructivist learning theory |
| ARCS model | Reinforcement theory | Cognitive load theory |
| Goal-setting theory | Transtheoretical model of behavior change | Social cognitive theory |
| Self-efficacy theory | Theory of reasoned action | Situated learning theory |
| Social comparison theory | Activity theory | Sociocultural theory of cognitive development |
| Achievement goal theory | | Social learning theory |
| | | Multimedia learning theory |

personality (Big Five; [472]). Table 5.4 and Table 5.5 illustrate the classified theoretical foundations according to their thematic focus and popularity in research on gamification, serious games and game-based learning.

[472]: Allport *et al.* (1936)

## 5.5 Discussion

This systematic review aimed to identify theoretical foundations in gamification, serious games, and game-based learning research. In total, 118 different theoretical foundations that are used to design and evaluate gamified interventions, and that help explain how gamification, serious games and game-based learning achieve their desired (motivational and affective, behavioral, and learning) effects, were identified. Although the overview of these theories already represents a valuable contribution to further research on the underlying mechanisms of gamification, there are also notable relationships that unify several of the theories presented. Moving from an observational to an explanatory level, the discussion of the commonalities between the theoretical foundations serves to identify their core assumptions to gain a more comprehensive understanding of how gamification works.

Figure 5.2 shows the relationships between the theoretical foundations most widely used in research on gamification, serious games and game-based learning, which are further elaborated below.

Each theory is presented as a bubble scaled according to the relative popularity of the theoretical foundation as identified in the systematic review. The bubbles are color-coded according to their thematic focus (motivation and affect, behavior or learning, see also Section B.3). As shown, some theories are marked with mixed color, indicating that their thematic focus is not clearly distinguishable. Straight arrows represent explicitly mentioned inclusions of one theory into another by the developing scientists. All the above-mentioned relations are objectively derived from the results of the systematic review. In addition, dashed lines indicate relationships concerning the main assumptions of two theories are hypothesized based on the detailed analysis.

Table 5.5: Other theoretical foundations in research on gamification, serious games and game-based learning (mentioned less than three times).

| Affect & Motivation | Behavior | Learning | Other |
|---|---|---|---|
| Cognitive evaluation theory | Fogg's behavior model | Discovery learning theory | Mechanics, dynamics and aesthetics framework |
| Health belief model | Information, motivation and behavior model | Stage theory of cognitive development | Uses and gratifications theory |
| Situational relevance theory | Unified theory of acceptance and use of technology | Theory of motivation, volition and performance | Theory of multiple intelligence |
| Immersion theory | Model model | Elaboration theory | Theory-driven gamification design model |
| Transportation theory | Rational choice theory | Constructionism | User-centered theoretical framework for meaningful gamification |
| Organismic integration theory | Ego depletion theory | Interest theory of learning | Control theory |
| Four drives theory | Parallel process model | Cognitive apprenticeship | Elaboration likelihood model |
| Person-artefact-task model | Theory of meanings of behavior | Universal design for learning | Taxation theory |
| Maslow's hierarchy of needs | Knowledge, attitude, behavior model | Presence pedagogy model | Diffusion of innovations theory |
| Murray's secondary psychological needs | Social network theory | Eisenkraft's 7E instructional model | Theory of organizational behavior |
| Transcontextual model of motivation | Premack's principle | Felder-Silverman learning style model | Communication theory |
| Situational interest theory | | Merrill's principles of instruction design theory | Theory of affordances |
| Attribution theory | | Technology-enhanced training effectiveness model | Moran's theorem |
| Expectancy-value theory | | Malone's theory | Guildford's structure of intellect |
| Affect transfer theory | | Lander's theory of gamified learning | Big five personality theory |
| Mood management theory | | Theory of gamified instructional design | Sexual health model |
| Cognitive dissonance theory | | Adult learning theory | Information systems success model |
| Play, affect and creativity theory | | Theory of realistic mathematics education | Mechanics, dynamics and emotions model |
| Taxonomy of intrinsic motivations for learning | | Prediction-observation-explanation model | Theory of interactive technology |
| Tripartite enjoyment model | | Scientific discovery as dual search model | Moral design framework |
| | | Self-directed learning theory | Middle-range theory of chronic illness |
| | | | Wisdom, intelligence and creativity synthesized theory |
| | | | Werbach's gamification framework |
| | | | Enactivism |
| | | | Actor-network theory |

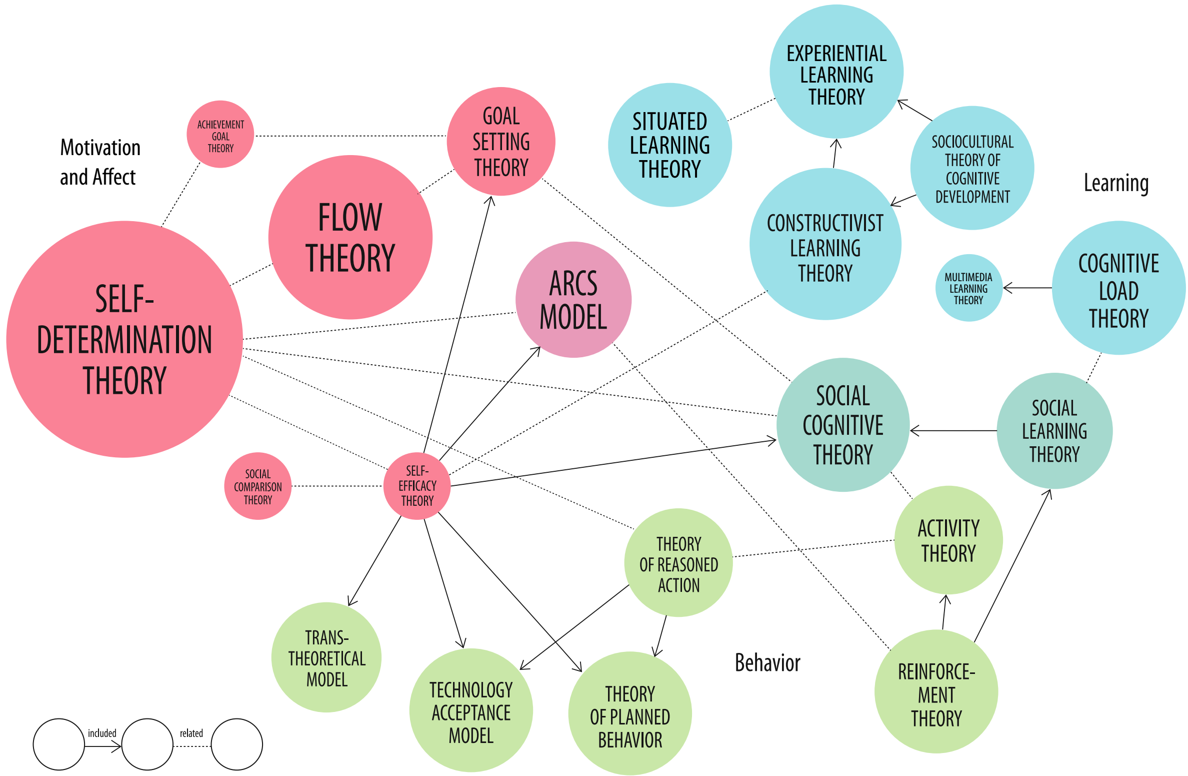


**Figure 5.2:** Theoretical landscape: Relationships of theoretical foundations in research on gamification, serious games and game-based learning.

According to goal-setting theory, goals must fulfill the criteria of both specificity and difficulty for them to be motivating [331]. From a motivational perspective, clear goals also support the emergence of flow experiences [392], [473], which are directly related to the concept of intrinsic motivation as articulated in SDT [474]: when individuals are fully involved in an activity, they experience the activity as intrinsically rewarding, and pursue it for the sake of the activity itself [392]. The ARCS model posits that clear goals represent major outcome expectations that particularly drive motivation when they are perceived as relevant and achievable [117]. From a self-determination view, clear goals support the need for competence, while relevant goals support the need for autonomy [474]. Also from a constructivist learning perspective, demonstrating and articulating the relevance of a goal is critical to supporting successful knowledge construction [339]. Behavioral theories such as the TRA [134] and the TPB [166] add that clear and relevant goals as outcome expectations promote a positive behavioral attitude, which then leads to behavioral intention and the actual desired behavior. Gamification and serious games can be valuable tools for illustrating goals and their relevance through elements such as badges and achievements, which have been shown to work similarly to classical goal-setting mechanisms [475] and even improve performance compared to classical goal-setting [476]. The introduction of challenges, sometimes called quests [413], can also serve as a goal mechanism [477], whereby the overarching goals are playfully broken down into specific sub-goals. Similarly, a predefined level system can provide students with goals to achieve [478]. Especially in game-based learning and serious games, stories or narratives can further reinforce the communication of specific learning goals [421] and chain goals together in an exciting story [479]. From this,

[331]: Locke (1968)
[392]: Csikszentmihalyi (2014)
[473]: Csikszentmihalyi *et al.* (1988)
[474]: Ryan *et al.* (2000)
[117]: Keller (1987)
[339]: Jonassen (1999)
[134]: Ajzen (1985)
[166]: Ajzen (1991)
[475]: Gutt *et al.* (2020)
[476]: Groening *et al.* (2019)
[413]: Klock *et al.* (2020)
[477]: Laine *et al.* (2020)
[478]: Ding *et al.* (2020)
[421]: Nebel *et al.* (2017)
[479]: Rapp (2017)

the first principle of how gamification works is derived:

**P1: Clear and relevant goals.** *Gamification can transparently illustrate goals and their relevance.*

SDT includes several sub-theories such as cognitive evaluation theory, organismic integration theory and basic psychological needs theory, and distinguishes between amotivation and different types of extrinsic and intrinsic motivation [474]. A specific sub-theory of SDT is goal-contents theory [261], which states that people have different foci in pursuing intrinsic and extrinsic aspirations or goals. This is similar to the main assumptions of achievement goal theory, which also suggests that individuals exhibit a mixture of achievement orientations in pursuit of goals [194], [480]. Thus, to promote the relevance of a particular intervention to subjects, individuals should be given the opportunity to set goals for themselves, which supports their need for autonomy [474] and, according to goal-setting theory, promotes positive affective responses to the goal, these being an important moderator of the goal-performance relationship [358], [374]. Social cognitive theory adds that the opportunity to set one's own goals is essential for self-regulation in learning [441]. Gamification research has emphasized that leaderboards are a main element for users to strive for their own goals [419], [420]. Furthermore, in game-based learning, customizable learning journeys with "level bosses" that must be defeated for each milestone achieved have been shown to support users in self-goal setting and thus self-regulated learning [481]. In addition, showing avatars that represent the user's future and ideal image can effectively serve as a role model for self-improvement of offline behaviors, such as a healthy lifestyle [482]. Performance stats and tracking features of gamified systems may also support users in self-monitoring processes for self-defined goals, especially related to diet, exercise, or medication [483]. Thus, the following principle of how gamification works is derived:

[474]: Ryan *et al.* (2000)
[261]: Ryan *et al.* (2017)
[194]: Elliot *et al.* (2001)
[480]: Elliot (1999)
[358]: Locke *et al.* (2013)
[374]: Locke *et al.* (2002)
[441]: Bandura (2001)
[419]: Chernbumroong *et al.* (2017)
[420]: Landers *et al.* (2017)
[481]: Chen (2019)
[482]: Rapp (2017)
[483]: Al-Ramahi *et al.* (2016)

**P2: Individual goals.** *Gamification can allow users to set their own goals.*

The need for competence as one of the three basic psychological needs mentioned in SDT is strongly linked to the concept of self-efficacy, i.e., a person's subjective conviction that he or she can successfully perform the desired behavior [352]. The importance of self-efficacy for effort and persistence in activities is so central that the construct is explicitly considered in several other theories: as a moderator in goal-setting theory [358], [374], as one of four factors in the ARCS model [117], as a mechanism in social cognitive theory [441], as a determinant in the TPB [426] and the TAM [118] and as a factor for decisional balance in the TTM [114]. Hence, the provision of self-efficacy information through performance accomplishments, vicarious experience, and verbal persuasion [359] is essential for motivation, learning and behavior change. Concerning *performance accomplishments*, all these theories state that immediate feedback on progress toward set goals is a sine qua non for perceptions of competence and self-efficacy. Furthermore, immediate feedback supports flow experiences [392], [473]. Studies indicate that one of the most widely used game elements [48], points, as well as levels and progress bars, can provide users with im-

[352]: Bandura (1982)
[117]: Keller (1987)
[441]: Bandura (2001)
[426]: Ajzen (2002)
[118]: Davis (1989)
[114]: Prochaska *et al.* (1997)
[359]: Bandura (1978)
[392]: Csikszentmihalyi (2014)
[473]: Csikszentmihalyi *et al.* (1988)
[48]: Koivisto *et al.* (2019)

mediate information about their actions and progress within the system, thereby presenting immediate feedback and visible progression [478], [484]. Feedback in serious games and game-based learning can also take the form of responses from dialogues with non-player characters or instant feedback messages related to game controls and challenges performed [477]. Consequently, the following principle of how gamification works is derived:

[478]: Ding *et al.* (2020)
[484]: Dicheva *et al.* (2015)

[477]: Laine *et al.* (2020)

**P3: Immediate feedback.** *Gamification can provide users with direct feedback on their actions.*

The ARCS model of motivation is an instructional design model. It is primarily a theory of motivation based on expectations and values, the latter being a person's preference for certain outcomes driven, for example, by the three basic psychological needs of SDT [366]. However, it can also be considered part as a learning theory because it focuses on motivation in an educational context. Instructional strategies for each of its factors – attention, relevance, confidence and satisfaction – include positive reinforcements, which are also emphasized by reinforcement theory [375]. Reinforcements, besides immediate feedback, also represent a form of performance accomplishments to promote self-efficacy [359], and continuous reinforcements are critical to maintaining behavior change from a TTM perspective [485]. Cognitive evaluation theory as a sub-theory of SDT adds that positive external stimuli must be primarily informative and not controlling in nature to achieve the desired effects [261]. In addition, both activity theory and social learning theory emphasize the central role of behavioral reinforcements but extend the sole significance of stimuli by a cognitive activity system [338] and observational learning processes [440]. While from a self-determination perspective [486], punishments or monetary incentives can be counterproductive as reinforcers, game elements such as badges and trophies [487], in-game rewards [424], praise messages [262], [270] or status symbols, which are commonly used in gamification systems, serious games and game-based learning [413], [479], are more informational in nature about the performance and relevance of the user's progress and thus can represent effective forms of reinforcements. Moreover, gamified environments can also offer effective incentives in the form of additional game features, including unexpected ones [482] or virtual gifts and loot [488]. Therefore, the following principle of how gamification works is derived:

[366]: Keller (1979)

[375]: Skinner (1953)

[359]: Bandura (1978)

[485]: Prochaska *et al.* (1992)

[261]: Ryan *et al.* (2017)

[338]: Vygotsky (1978)

[440]: Bandura (1971)

[486]: Ryan *et al.* (2020)

[487]: Suh *et al.* (2018)

[424]: Berkovsky *et al.* (2012)

[262]: Carenys *et al.* (2016)
[270]: Kordaki *et al.* (2017)

[413]: Klock *et al.* (2020)
[479]: Rapp (2017)

[482]: Rapp (2017)

[488]: Xu *et al.* (2020)

**P4: Positive reinforcement.** *Gamification can reward users for their performance and communicate the relevance of their achievements.*

On the other hand, the importance of *vicarious experience* [359], that is, observing the performance of others, is essential not only for motivation but also for social learning processes as outlined in social learning theory [440]. Social cognitive theory, which builds on social learning theory, integrates the role of vicarious learning by observation, self-efficacy, and self-regulation by goal-setting into what is called a self-system [329]. It parallels the activity system postulated in activity theory [338]), thus emphasizes the importance of both social comparisons and self-imposed goals for learning. From a different perspective, cognitive load theory states that most knowledge in long-term memory is acquired by observing

[329]: Bandura (2001)

[338]: Vygotsky (1978)

others, which is expressed in the borrowing and reorganizing principle [489]. Vicarious experience is also central to social comparison theory, which states that people have a natural urge to evaluate their abilities in comparison with others [389]. In this context, the opportunity to make private comparisons and the certainty of not revealing one's inferiority to others are essential for social comparison processes to be motivating [390]. Research has demonstrated that gamification, serious games and game-based learning can represent suitable interventions to facilitate social comparisons, e.g., with elements such as leaderboards [391] or status symbols and rankings [478]. Moreover, social comparisons can manifest in duels and contests [413] or reputation systems [479] and in-game communication [477] that enable interindividual social recognition. Social comparison and competition in gamified systems is perceived as motivating by most users [490] and intra- and inter-team competitions have been shown to be critical mechanisms for motivation and participation in gamified systems [491]. Likewise, competitive game elements are pivotal mediators of team effort and performance [492]. As a result, the following principle of how gamification works is derived:

[489]: Sweller (2010)
[389]: Festinger (1954)
[390]: Buunk *et al.* (2007)
[391]: Christy *et al.* (2014)
[478]: Ding *et al.* (2020)
[413]: Klock *et al.* (2020)
[479]: Rapp (2017)
[477]: Laine *et al.* (2020)
[490]: Bayuk *et al.* (2019)
[491]: Morschheuser *et al.* (2019)
[492]: Dissanayake *et al.* (2019)

**P5: Social comparisons.** *Gamification can allow users to see their peer's performance.*

The TRA introduces a new aspect: in addition to the behavioral attitude based on outcome expectations, behavioral intention depends on the subjective norm, i.e., normative beliefs towards peer expectations [134]. Activity theory strongly supports the importance of community and cultural rules in the activity system [493], and the basic psychological need of relatedness from SDT expresses the crucial need for conformity and proximity with peers [261]. As extensions of the TRA, the TPB [166] and the TAM [118] also incorporate the importance of normative beliefs as determinants of behavioral intention. This suggests that social comparison mechanisms should be reinforced through the exertion of social pressure and support for a common goal. Gamification, serious games, and game-based learning can allow users to form teams, master team challenges, collectively vote on options and connect in social networks [413]. Dividing users into subgroups or teams and supporting their interdependence through shared gamified tasks may create a sense of belonging and positively foster the process of behavior change [479], [482]. For example, game-based learning systems can require students to participate in group activities in a collaborative space [436]. In addition, exchange guilds allow people to support each other with appropriate suggestions when facing difficulties [482]. In this regard, communication in games and gamification that enables social support can be realized synchronously, e.g. through chats, or asynchronously, e.g. through discussion forums [431], [477]. Furthermore, the introduction of social network features with mentoring influencers [482] or the conveyance of social norms through the presentation of average statistics [427] can represent suitable game elements for influencing normative beliefs towards behavior change. From this, the following principle of how gamification works is derived:

[134]: Ajzen (1985)
[493]: Engeström (2001)
[261]: Ryan *et al.* (2017)
[166]: Ajzen (1991)
[118]: Davis (1989)
[482]: Rapp (2017)
[436]: Carron *et al.* (2008)
[431]: Vanduhe *et al.* (2020)
[477]: Laine *et al.* (2020)
[427]: Rai *et al.* (2017)

**P6: Social norming.** *Gamification can connect users to support each other and work towards a common goal.*

The TTM assumes that behavioral changes occur in four distinct phases [485]. In each phase, different psychological processes take place that must be supported to lead to the subsequent stage. Although not directly related to phases and thus not a direct theoretical link, other theoretical foundations also emphasize inter-individual differences. SDT [486], flow theory [330], [494] and self-efficacy theory [352] recognize that people differ in their abilities but share similar needs for competence. Goal-setting theory [358], [374] includes ability and personality as critical moderators of the goal-performance relationship. And constructivist learning theory [339] which includes both individual constructivism [449] and the sociocultural theory of cognitive development [338], emphasizes the importance of *scaffolding*, i.e. adjusting and structuring tasks to the learner's abilities to support successful learning. Thus, it is important to tailor tasks and complexity to the individual's skills, knowledge, and behavioral level. Gamification and serious games have been shown to be appropriate tools to illustrate learning potentials at a current stage [413], e.g., through knowledge maps [495] and skill trees [496]. Moreover, challenges in gamification and game-based learning systems can be tailored to the learner's current skill level [484], e.g., by tying the difficulty of the challenge to levels [497], [498] or by using machine learning algorithms [498]. In this respect, educational games surpass traditional teaching methods [447]. In terms of behavioral change, fictional avatars can be designed in serious games to go through the different behavioral phases [433], and various gamification elements can be selected to support the different stages of behavioral change [479], e.g. statistics and messages for initial information provision in the pre-contemplation stage, followed badges and rewards to reinforce the user's effectiveness in the preparation stage and level-ups or leaderboards in the action and maintenance stage [432], [434]. Thus, the following principle of how gamification works is derived:

[485]: Prochaska *et al.* (1992)

[486]: Ryan *et al.* (2020)

[330]: Csikszentmihalyi (1975)
[494]: Csikszentmihalyi (2013)

[352]: Bandura (1982)

[358]: Locke *et al.* (2013)
[374]: Locke *et al.* (2002)

[339]: Jonassen (1999)

[449]: Piaget (1977)

[338]: Vygotsky (1978)

[413]: Klock *et al.* (2020)

[495]: Borges *et al.* (2016)

[496]: Barata *et al.* (2017)

[484]: Dicheva *et al.* (2015)

[497]: Simões *et al.* (2013)
[498]: Gordon *et al.* (2013)

[447]: Davis *et al.* (2018)

[433]: Bahia *et al.* (2014)

[432]: Alsaleh *et al.* (2020)
[434]: AlSkaif *et al.* (2018)

**P7: Adaptive content.** *Gamification can adapt tasks and complexity to the abilities and knowledge of the user.*

According to constructivist learning theory, in addition to adaptive content, coaching, i.e., supporting learning through motivational prompts, assistance, and reflection [339] plays a central role in successful knowledge construction. Sociocultural constructivism underlines that for learners to progress, it is imperative that they be guided within their zone of proximal development [338]. Similarly, the TPB [166] emphasizes the importance of actions that nudge the individual to reach the next stage of behavioral change, which is referred to as verbal persuasion in self-efficacy theory [352]. Gamified systems have been shown to be effective tools for nudging [499], [500]. For example, gamification and serious games can provide guidance through elements such as suggestions, tips, messages and highlighting of items or elements [413], that help, suggest, or warn to follow a path (or not). In addition, role-playing can be used to guide students through different aspects of a problem [453]. Hence, the following principle of how gamification works is derived:

[339]: Jonassen (1999)

[166]: Ajzen (1991)

[499]: Afshar Jalili (2019)
[500]: Kwan *et al.* (2020)

[453]: Hwang *et al.* (2015)

**P8: Guided paths.** *Gamification can nudge users towards the actions necessary for achieving the goals.*

Experiential learning theory, which builds on constructivist learning theory and the sociocultural theory of cognitive development [501], assumes that knowledge is acquired primarily through personal and environmental experiences rather than instruction [452]. Situated learning theory extends this notion, stating that conceptual knowledge cannot be abstracted from the situations in which it is learned and applied [370]. Hence, learning environments need to be designed authentically so that students can learn by linking their prior knowledge to real-world scenarios as they participate in learning activities [453]. For example, through problem-based learning, case-based learning, and cognitive apprenticeship, learning can be embedded in realistic contexts and supports experimentation with multiple perspectives and ways to solve problems [502]. This is also relevant to support feelings of autonomy, one of the three basic psychological needs of SDT [261]. Gamification can allow users to discover and choose multiple different paths and options on the way to a goal [484], e.g. through mechanics such as nonlinear gameplay or branching decisions [413]. For example, game-based learning systems such as Duolingo provide choices between different paths of learning tasks and tests [448]. Moreover, serious games can offer fictional environments in which learners can act freely and explore and try different paths and options to achieve the goal [479] and learn about specific topics [459]. Augmented reality games allow for similar exploration in real-world environments [457]). Therefore, the following principle of how gamification works is derived:

[501]: Kolb *et al.* (2013)

[452]: Kolb (1984)

[370]: Brown *et al.* (1989)

[453]: Hwang *et al.* (2015)

[502]: Dabbagh *et al.* (2013)

[261]: Ryan *et al.* (2017)

[484]: Dicheva *et al.* (2015)

[413]: Klock *et al.* (2020)

[448]: Rachels *et al.* (2018)

[479]: Rapp (2017)

[459]: Wrzesien *et al.* (2010)

[457]: Furió *et al.* (2013)

**P9: Multiple choices.** *Gamification can allow users to choose between several different options to achieve a certain goal.*

Finally, the TAM emphasizes the importance of ease of use in the acceptance of information systems [118], so that users perceive self-efficacy [352] in using the system. Similarly, multimedia learning theory [460], based on cognitive load theory [116], suggests the importance of ease of use to minimize extraneous cognitive processing that distracts users from actively processing the learning content [503]. Game-based learning and serious games can divide complex tasks into shorter and simple sub-tasks [497]. In addition, educational simulations can support learning by abstracting real-world problems and contexts to their essential characteristics [504]. Studies have shown that game-based learning can successfully direct cognitive effort towards essential and generative processing when designed with, for example, self-explanation features [463] and explanatory feedback [503]. Moreover, onboarding also referred to as tutorials, can provide users with relatively simple tasks to get started familiarize themselves with the system [505], [506] . Consequently, the following final principle of how gamification works is derived:

[118]: Davis (1989)

[352]: Bandura (1982)

[460]: Mayer (2005)

[116]: Sweller (1988)

[503]: Mayer *et al.* (2010)

[497]: Simões *et al.* (2013)

[504]: Ranchhod *et al.* (2014)

[463]: Johnson *et al.* (2010)

[505]: Kavaliova *et al.* (2016)
[506]: Iosup *et al.* (2014)

**P10: Simplified user experience.** *Gamification systems are usually easy to use and can simplify content.*

The discussion of relationships between the theoretical foundations used in research on gamification, serious games and game-based learning thus

enables the identification of ten underlying theoretical principles that help explain how gamification can achieve its positive effects, summarized in Table 5.6. To enhance the overview, I distinguish three categories of

Table 5.6: Theoretical principles that help explain the effects of gamification.

| Theoretical principles | Related theoretical foundations |
|---|---|
| Principles that guide towards the intended behavioral outcomes | |
| **P1: Clear and relevant goals.** Gamification can transparently illustrate goals and their relevance. | Goal-setting theory, flow theory, self-determination theory, ARCS model, constructivist learning theory, theory of reasoned action, theory of planned behavior |
| **P3: Immediate feedback.** Gamification can provide users with direct feedback on their actions. | Self-determination theory, self-efficacy theory, goal-setting theory, ARCS model, social cognitive theory, theory of planned behavior, technology acceptance model, transtheoretical model of behavior change, flow theory |
| **P4: Positive reinforcement.** Gamification can reward users for their performance and communicate the relevance of their achievements. | Reinforcement theory, ARCS model, self-efficacy theory, transtheoretical model of behavior change, self-determination theory, activity theory, social learning theory |
| **P8: Guided paths.** Gamification can nudge users towards the actions necessary for achieving the goals. | Constructivist learning theory, sociocultural theory of cognitive development, theory of planned behavior, self-efficacy theory |
| **P10: Simplified user experience.** Gamification systems are usually easy to use and can simplify content. | Technology acceptance model, multimedia learning theory, cognitive load theory |
| Principles that foster individual relevance | |
| **P2: Individual goals.** Gamification can allow users to set their own goals. | Self-determination theory, achievement goal theory, goal-setting theory, social cognitive theory |
| **P7: Adaptive content.** Gamification can adapt tasks and complexity to the abilities and knowledge of the user. | Transtheoretical model of behavior change, self-determination theory, flow theory, self-efficacy theory, goal-setting theory, constructivist learning theory, sociocultural theory of cognitive development |
| **P9: Multiple choices.** Gamification can allow users to choose between several different options to achieve a certain goal. | Experiential learning theory, situated learning theory, self-determination theory |
| Principles that enable social interaction and positive social effects | |
| **P5: Social comparisons.** Gamification can allow users to see their peer's performance. | Self-efficacy theory, social cognitive theory, social learning theory, cognitive load theory, social comparison theory |
| **P6: Social norming.** Gamification can connect users to support each other and work towards a common goal. | Theory of reasoned action, activity theory, self-determination theory, theory of planned behavior, technology acceptance model |

principles: those that lead people to the intended results, those that enhance individual relevance, and those that enable social interaction and positive social effects on individual behavior.

## 5.6 Implications

The foregoing review and discussion constitute the first to explicitly focus on the theoretical foundations used in research on gamification, serious games and game-based learning. Moving from an observational perspective to an explanatory perspective, I examined the theoretical foundations used to design and evaluate gamified interventions and explain the effects of gamification, serious games and game-based learning in this systematic meta-review. Subsequently, I highlighted the common underlying principles of the most prevalent theories identified in the review that help explain how gamification, serious games and game-based learning can achieve positive affective and motivational, (cognitive) learning and behavioral effects. The findings provide valuable guidance for further theoretical research as well as for the practical design and use of gamification in various application contexts.

### 5.6.1 Implications for Theory

This systematic meta-review has shown that the landscape of theoretical foundations that have so far been used to explain how gamification, serious games and game-based learning influence affect and motivation, behavior, and learning in different contexts, has acquired a fascinating variety. In conjunction with the growing interest in gamification research, this is a positive sign: While in earlier stages of gamification research, the focus has been set primarily on *whether* gamification produces positive effects [111], this review demonstrates that scientific interest has successfully broadened and expanded by investigating *how* and *why* this takes place.

[111]: Nacke *et al.* (2017)

SDT is an omnipresent theoretical framework in gamification research. It is by far the most used theory to this date. It was used in 82 papers, followed in popularity by flow theory, constructivist learning theory, experiential learning theory and cognitive load theory as the most common theories. In contrast, 54 of the 118 theories identified have only been used once so far. This observation may be explainable by the fact that SDT depicts a macro-theory of human motivation, development, and health [474], and hence marks a broad framework by definition. The finding that SDT is also one of the theories most often associated with other theoretical foundations (see Figure 5.2 and Table 5.6) supports this assumption. Similarly, several of the most prevalent theories may generally be applicable in different contexts since psychological constructs such as flow or behavioral determinants from the TPB have not been developed to explain motivation and behavior in specific contexts but rather in general terms. Other theoretical foundations, especially those that were used by only one or two papers, are more context-specific (e.g. Sexual Health Model; [471]), which may explain their lower popularity.

[474]: Ryan *et al.* (2000)

[471]: Robinson (2015)

It remains to be answered why some crucial theories, such as self-efficacy theory, which is a theoretical basis for much more commonly used theories (e.g. the TPB, social cognitive theory and the TAM, as shown in Figure 5.2), are not adequately investigated to explain the effects of gamification, serious games and game-based learning. Likewise, expectancy-value theory [507] has only been mentioned in one of the reviews, while it provides essential insights for explaining motivational differences based on presumptions about behavioral consequences and forms the basis for the much more popular ARCS model [366]. Why are certain theories preferred in this case? Further theoretical research should explore the possibility of making greater use of the theories that form the basis for others, in order to examine whether the observable choice of theoretical foundations is due to the actual added value of the most popular theories, or rather a result of the application context (e.g., the ARCS model for instructional design might

[507]: Lawler *et al.* (1967)

[366]: Keller (1979)

simply be more familiar to educational researchers than the underlying expectation-value theory).

In addition, important connections and interrelations between the theories (indicated as dashed lines in Figure 5.2) can be suspected, which are based on the main assumptions of the respective theories. Since the principles that help to explain how gamification works were derived from these relationships, further studies are invited to investigate and validate these theoretically established links.

The great variety of 118 different theoretical foundations in use also shows that there is no single theory that can explain how gamification works. Moreover, it reflects that gamification is an important and developing (research) topic in various contexts. The theoretical bases in gamification, serious games and game-based learning research address different outcomes regarding motivation and affect, behavior, and learning, and reflect attempts to explain the effects of gamification from different angles. As Keller [269] has pointed out in the context of motivation, volition and performance, one of the future goals of gamification research should be to consider a broader variety of theoretical foundations to demonstrate empirically how gamification works, rather than choosing only one of these theories. For example, it is useful to find out how gamification motivates, but it becomes even more effective if these insights are directly linked to how gamification also transforms motivation and intention into behavior and learning outcomes. Since many theoretical foundations are at least partially interlinked, gamification research could benefit from such synergies. In this work, I tried to derive basic principles from the core assumption of several theories that help explain the effects of gamification. In future empirical research, these theoretically deducted principles should be tested, challenged, and refined, so that the “how” and “why” of gamification can be explained even more concretely and precisely.

[269]: Keller (2008)

### 5.6.2 Implications for Practice

The present systematic review demonstrates that gamification, serious games and game-based learning provide a high potential for improving affect and motivation, behavior and learning outcomes in various important areas such as education, health, work, or sustainability. When there is a lack of motivation or performance or if learning behavior and outcomes display room for improvement, gamification can represent a suitable solution when it is a successful manifestation of several principles deemed important by theories on motivation and affect, behavior, and learning. Especially in contexts where motivation usually fades over time, such as education [508], gamification, serious games and game-based learning might be useful tools to engage learners in continuous learning, especially since it has been shown that teachers often lack preparation on how to motivate their students [509]. Including theory on gamification, serious games and game-based learning and their impact into teacher education therefore is another crucial practical implication of this research. The same counts for practitioners in other fields: While research has already addressed the previously criticized lack of theoretical foundations in research interventions on gamification and serious games, practice should now be invited to follow up with gamification design built on these theoretical findings. This applies to all contexts in which gamification has been used

[508]: Wigfield *et al.* (2007)

[509]: Schürmann *et al.* (2020)

in the past and will be used in the future, including, for example, health, the workplace or education.

Those who want to benefit from gamification, serious games and game-based learning, such as teachers, managers or physicians, need to develop competencies regarding the underlying theoretical foundations and their principal commonalities. For example, teachers who want to adopt gamification to motivate and engage their students and improve learning outcomes should understand the importance of (P1) clear and relevant goals as well as (P8) guided paths to connect game elements, make sure that the students get (P3) immediate feedback and are thereby (P4) positively reinforced, that the (P10) user experience is simple and supports the work on (P2) individual goals, while the system provides (P7) adaptive content and (P9) choices on the side of the students. A possibility for (P5) social comparison and (P6) social norming should also be given to achieve the best results. In light of these recommendations, it is important to note that the appropriate choice of principles still depends on the context and goals of gamification, and not every principle is necessarily appropriate in every case. For example, an intervention aimed at driving the efforts of student teams to collaboratively discover solutions to gamified problems might intentionally omit social comparisons to avoid competitive dynamics. This highlights that practitioners need to develop *gamification literacy* in the sense of an ability to engage with gamification-related issues and ideas of gamification within their application context. Teachers, managers, doctors, and all those who want to benefit from gamification need to learn how to implement it concerning their specific goals. This is particularly relevant in the educational and work context now as digital education and remote working become more widespread, for instance, due to the Covid-19 pandemic.

Conclusively, it is apparent that practitioners need to understand the underlying theories and especially the derived basic principles and how they relate to motivation and affect, behavior, and learning, so that gamification practice can benefit from a solid theoretical basis and interventions can be designed adequately and successfully to achieve the desired results.

## 5.7 Conclusion and Limitations

This systematic review has shown that scientific work on gamification, serious games and game-based learning has used a variety of theoretical foundations from different perspectives to design and evaluate gamified interventions and explain the psychological mechanisms by which gamification achieves its positive outcomes, including theories on motivation and affect, behavior and learning. Most of the theories identified in the course of this review comprise explicitly formulated or conceptual connections, which were illustrated in a graphical representation of the theoretical foundations of gamification research (Figure 5.2). From their interrelationships, I derived basic theoretical principles that help explain how gamification works: Through game elements such as points, levels, badges, quests, and many more, gamification can transparently *illustrate goals* and their relevance, lead users through *guided paths* to goal-oriented activities, give users *immediate feedback* and *reinforce good performance* positively, and *simplify content* to manageable tasks. The gamification mechanics can allow users to *pursue individual goals* and *choose between several different progress paths*, while the gamified systems can *adapt tasks and complexity* to the user's abilities. Social gamification elements may enable *social comparison* and *connect users* to support each other and work towards a common goal.

However, this study is not without limitations. First, the choice of an umbrella review of the scholarly literature as an appropriate methodological choice to aggregate the divergent findings of the multitude of existing reviews on theoretical foundations of gamification, serious games, and game-based learning may have missed empirical or conceptual studies that develop a novel theory based on other theoretical foundations, or non-peer-reviewed research contributions to theoretical foundations, e.g., in book chapters.

Second, the evaluation of the popularity of various theoretical foundations was based both on the number of reviews in which any given theory is mentioned and on the scope of the primary research studies in which it was applied. However, five of the 32 reviews that were meta-analyzed did not provide the sum of primary studies that used a particular theory, so the total number of studies listed in the review may be biased. However, the theories mentioned in the respective reviews fit the general distribution of theories in research, so it is likely that the divergent sum of the studies does not affect the results.

Third, I have studied the conceptual links between different theoretical foundations in detail. However, I would like to emphasize that neither the theoretical landscape nor the conceptually derived principles claim to be complete and are open for further development by other scientists. I have, for example, only compared the 21 most popular theories to derive the theoretical principles that help explain how gamification works. There are at least 95 more theories used in primary studies that future research could investigate and link to the effects of gamification, serious games and game-based learning in general or other theories and different contexts in particular. The resulting implications and core assumptions for gamification, serious games and game-based learning are still to be investigated. Also, the derived principles are based primarily on a conceptual discussion, and further empirical research is needed to support their validity and investigate how well the different principles can explain the effects of gamification, serious games and game-based learning.

Finally, it should be noted that the theoretically derived principles that help explain how gamification works share parallels with several design guidelines for successful gamification (e.g. [123], [124], [257], [510]. It would support both the validity of these theoretical findings and the validity of the design principles if the basic assumptions on the principles of gamification that lead to its positive outcome matched the guidelines for successful gamification design, and further research is invited for such a profound comparison. In this way, research can gradually gain an accepted understanding of how gamification works and how it must be realized to be successful, thereby reducing or explaining potentially ambiguous results about outcomes and advancing the effective application of gamification and serious games in various application contexts.

[123]: Morschheuser *et al.* (2018)
[124]: Liu *et al.* (2017)
[257]: Israel *et al.* (2013)
[510]: Sezgin *et al.* (2020)

The preceding review of the theoretical foundations in research on gamification, serious games, and game-based learning led to the following key insights for the design of the gamified app in the first DSR cycle:

- There are many different theories related to motivation and affect, behavior and learning that help design and explain the effects of gamification
- The most prevalent theories share explicit or implicit conceptual relationships
- From these conceptual relationships, ten key theoretical principles can be derived to explain how successful gamification design guides toward intended behavioral outcomes, fosters individual relevance, and enables social interaction and positive social effects:
  - Clear and relevant goals
  - Individual goals
  - Immediate feedback
  - Positive reinforcement
  - Social comparisons
  - Social norming
  - Adaptive content
  - Guided paths
  - Multiple choices
  - Simplified user experience

Together with the design principles that will be identified through the systematic review in Chapter 6, these theoretical principles form the theoretical basis for the development of the first prototype of the envisioned gamified application.

# Study 3: Systematic Review on Design Principles for Gamification and Persuasive Systems 6



## 6.1 Context and Aim of this Study

The preceding systematic review of the theoretical foundations of research on gamification, serious games and game-based learning has led to an in-depth understanding of the psychological mechanisms of gamification and to the identification of ten common theoretical principles that help explain how successful gamification achieves its effects. These theoretical principles can, in turn, help to shape the design of gamification to meet these theoretical principles.

However, when it comes to successful gamification design, the existing knowledge on design principles that comes from user-centred empirical research should not be neglected. The aim of this study is to broaden the theoretical perspective and complement the theoretical findings with empirically generated knowledge from previous studies that have developed and tested different design principles for gamification, game-based systems and persuasive systems - a related concept with a broader focus than gamification, but similarly aimed at changing behaviors towards a desired outcome [244], [245]. In this way, the combination of theoretical and empirical perspectives provides the basis for a grounded development of design suggestions in the first DSR cycle.

**Publication of this study.**

The content of this study has been published in a similar form in [1] J. Krath and H. F. O. von Korflesch, "Designing gamification and persuasive systems: a systematic literature review", in 5th International GamiFIN Conference, [Online], Apr. 2021, pp. 100–109, https://ceur-ws.org/Vol-2883.

[244]: Werbach (2014)
[245]: Deterding (2014)

Gamification design has received scholarly attention in various disciplines [84], [123], [124]. Recent systematic reviews have analysed design methods [123], [250], [511] and conceptual models [250] of game design. However, a comprehensive overview of design principles is still lacking, with existing syntheses limited to the contexts of education [477], [484], [512] and energy games [513]. Design principles provide an important bridge between the other two levels of abstraction - design methods and models on the one hand, and design patterns and motivational affordances on the other. They help practitioners, such as teachers, physicians or managers, to select appropriate game design patterns [221] that lead to the desired outcomes.

[84]: Oppong-Tawiah *et al.* (2020)
[123]: Morschheuser *et al.* (2018)
[124]: Liu *et al.* (2017)
[250]: Mora *et al.* (2017)
[511]: Deterding (2015)
[477]: Laine *et al.* (2020)
[484]: Dicheva *et al.* (2015)
[512]: Lämsä *et al.* (2018)
[513]: Fijnheer *et al.* (2016)
[221]: Deterding *et al.* (2011)

A variety of design principles for gamification and persuasive systems have been proposed by scholars from different disciplines, e.g. health [255], [256], [514], education [257], [258], sustainability [84], [513] and fitness [259]. This increasing diversity reinforces the need for a systematic overview that enables researchers and practitioners alike to successfully choose an appropriate gamification design.

[255]: Wang *et al.* (2019)
[256]: Cafazzo *et al.* (2012)
[514]: Mintz (2013)
[257]: Israel *et al.* (2013)
[258]: Plass *et al.* (2015)
[259]: Kappen *et al.* (2016)

To address this issue, this systematic review aims to *identify and analyze existing research on design principles for gamification and persuasive systems*. More than 60 different design principles are presented and conceptually linked to exemplary design patterns and motivational affordances. The resulting framework bridges the gap between existing reviews of design processes and design patterns and contributes to a comprehensive guide for researchers and practitioners in gamification design.

## 6.2 Theoretical Background

As already reflected in Chapter 3, game elements include patterns, objects, principles, models and methods inspired by games [49]. Game *interface design patterns* [221] include concrete design solutions such as badges, leaderboards or levels [221]. Closely related to this are game *design patterns* that relate to game mechanics, such as time constraints and turns [221]. Both interface design patterns and design patterns can also be referred to as *motivational affordances*, which, from an experiential rather than system-oriented perspective, include game components that support the user in achieving the desired behavioral outcome [226]. Game interface design patterns and design patterns or motivational affordances represent a low level of abstraction in gamification design. The selection of motivational affordances is guided by *design principles*. Design principles are defined as evaluative guidelines for approaching a design problem or analyzing an existing solution [221] and form the bridge between low-level motivational affordances and high-level game models and design methods. While *game models* refer to the conceptual framework of the game components [221], *game design methods* describe the practices and processes or steps of game development [221].

[49]: Seaborn *et al.* (2015)

[221]: Deterding *et al.* (2011)

[226]: Huotari *et al.* (2017)

While existing academic research still mainly focuses on game interface design patterns and design patterns [245], more recently design methods or processes [123], [250], [511] and conceptual game models [250] used in gamification design have also been analyzed. However, a comprehensive overview of game design principles, which is the important bridge between the other two levels of abstraction, is still missing.

[245]: Deterding (2014)

[123]: Morschheuser *et al.* (2018)
[250]: Mora *et al.* (2017)
[511]: Deterding (2015)

Gamified systems are not the only technology that aims to influence motivation, attitudes and behavior in non-game contexts. Rather, as elaborated in Chapter 3, gamified systems represent a subset of persuasive systems [244],[245]. Persuasion or persuasive systems as a broader concept describes technologies that seek to reinforce, change or shape attitudes or behaviors or both [238], which includes the use of gamified design [245], [246]. In addition to this general relationship between gamification and persuasion [515], some studies specifically examine the use of gamification in persuasive systems [516], [517], indicating the potential of gameful design for persuasion.

[244]: Werbach (2014)

[238]: Fogg (2003)

[246]: Hamari *et al.* (2014)

[515]: Llagostera (2012)

[516]: Böckle *et al.* (2020)
[517]: Nystrom (2017)

Conversely, gamification design principles that aim to shape attitudes or behaviors should not be limited to game-based design - instead, a more holistic perspective that incorporates insights from non-game persuasive systems is required to design gamification to achieve the desired motivational and behavioral outcomes [245].

Therefore, consideration of design principles from both gamification and persuasive systems research is necessary to provide a comprehensive overview for deriving successful design principles.

## 6.3 Research Method

The systematic literature review was conducted in line with the recommendations of Paré et al. [106] and Webster and Watson [104] for descriptive

[106]: Paré *et al.* (2015)

[104]: Webster *et al.* (2002)

reviews. Descriptive reviews generally attempt to determine the extent to which a corpus of empirical studies in a particular area of research supports or reveals interpretable patterns or trends with respect to existing theses, theories, methods, or outcomes [105]. This usually involves the use of structured search methods to create a representative sample from a larger group of published works that relate to a particular area of inquiry [106]. Authors of descriptive reviews seek to identify interpretable trends and patterns or to draw general conclusions about the merits of existing conceptualizations, theses, methods, or findings [106]. Hence, the method of a descriptive review was identified as appropriate to answer the following primary research question by synthesizing the results of existing studies on design principles:

[105]: King *et al.* (2005)

[106]: Paré *et al.* (2015)

**Research question:** *What design principles are proposed by research on gamification and persuasive systems?*

**Search strategy.** The ROSES [107] contained detailed instructions on the individual steps of the screening and selection process. Seven scientific databases were searched to identify the relevant literature (Web of Science Core Collection, EBSCO Host (APA PsychArticles, APA PsychInfo, Business Source Premier), Wiley Online, ScienceDirect, SagePub, IEEE Explore and Taylor & Francis). These multidisciplinary databases were selected because they index a wide range of journals, complemented by IEEE Explore as a specific database for the IS research area. In order to include as many relevant results as possible, I searched for articles related to the design principles of gamification or persuasive systems, using different terms such as principle, guideline, framework, strategy or recommendation. In addition, I used the broader term ”gamif*,” which incorporates verbs such as ”gamified,” to include design guidelines that relate to game-based learning or serious games. The search was therefore conducted in September 2020 using the following search term:

[107]: Haddaway *et al.* (2018)

**Search string:** *TITLE-ABS-KEY(”Gamif*” OR ”Persuasive system*” OR ”Persuasive technology”) AND (”design guideline*” OR ”design framework*” OR ”design principle*” OR ”design strateg*” OR ”design recommendation*”)*

**Screening strategy and inclusion criteria.** Following the ROSES standard [107], screening was carried out in three steps: Title Screening, abstract screening and full text screening. To ensure the quality of the research, only empirical and conceptual studies from peer-reviewed journal articles and peer-reviewed conference papers were included in the final sample. Conference papers were considered important because they account for a significant proportion of citations in computer science and human-computer interaction research [296] and because the identification of studies from conference proceedings in systematic reviews is generally accepted as good practice [297]. As a language criterion, only English-language articles were included. In addition, studies that developed design principles for the design of a gamified or persuasive application either in general or in a specific application domain were included, but excluded if they only used or examined existing design principles or if they focused on the design process, game model, game elements or functional requirements.

[296]: Michels *et al.* (2014)

[297]: Scherer *et al.* (2019)

Table 6.1: Inclusion and exclusion criteria for the review on design principles for gamification and persuasive systems.

| Criterion | Included | Excluded |
|---|---|---|
| Language | English | Other languages, e.g. Spanish, German, Russian, Korean, Chinese, Japanese |
| Publication type | Peer-reviewed journals, peer-reviewed conference papers | Book chapters, magazine articles, reports, these, other gray literature |
| Type of study | Conceptual or empirical studies | Systematic reviews, editorial articles |
| Study topic | Gamification, serious games, game-based learning, persuasive systems | Video games |
| Study content | Development or suggestion of design principles | Examination of existing design principles, focus on design process, game model, game elements or functional requirements |

The inclusion and exclusion criteria for the article screening are summarized in Table 6.1.

**Critical appraisal strategy.** For the critical assessment of the quality of the reviewed articles, the following criteria were checked for each individual study:

1. Did the authors formulate at least one clear research question or research goal?
2. Did the authors describe their research method?
3. Did the authors answer their research question(s)/goal(s) properly?

Figure 6.1 illustrates the result of the search strategy and screening process. A total of 30 articles remained for data extraction and synthesis. For reasons of reproducibility, the entire list of excluded full texts is attached in Section C.1.

**Data extraction strategy.** Metadata such as title, year of publication, authors, publication type (journal or conference volume) and publication name of the articles were extracted with the Mendeley Reference Manager and manually checked during import. Following the guidelines of Webster and Watson [104], author-centred qualitative data extraction involved coding the domain and methodological approach of the study, as well as the topic focus (gamification or persuasion) and the design principles proposed in the respective articles. In the subsequent concept-centred phase, the coded results were analyzed and organized into frequency matrices.

[104]: Webster *et al.* (2002)

## 6.4 Results

In the analysis, I first narratively report on the quality of the reviewed sample, the research areas, and the methods of the articles studied, followed by the qualitative analysis of the design principles presented.

### 6.4.1 Sample Quality, Research Areas, and Methods

In critical appraisal of the sample's quality, it can be stated that the majority of the articles included were published in peer-reviewed journals, most of which are highly ranked in the Scientific Journal Ranking (SJR) and Journal Impact Factor (JIF). 12 out of 22 journal articles were published in the

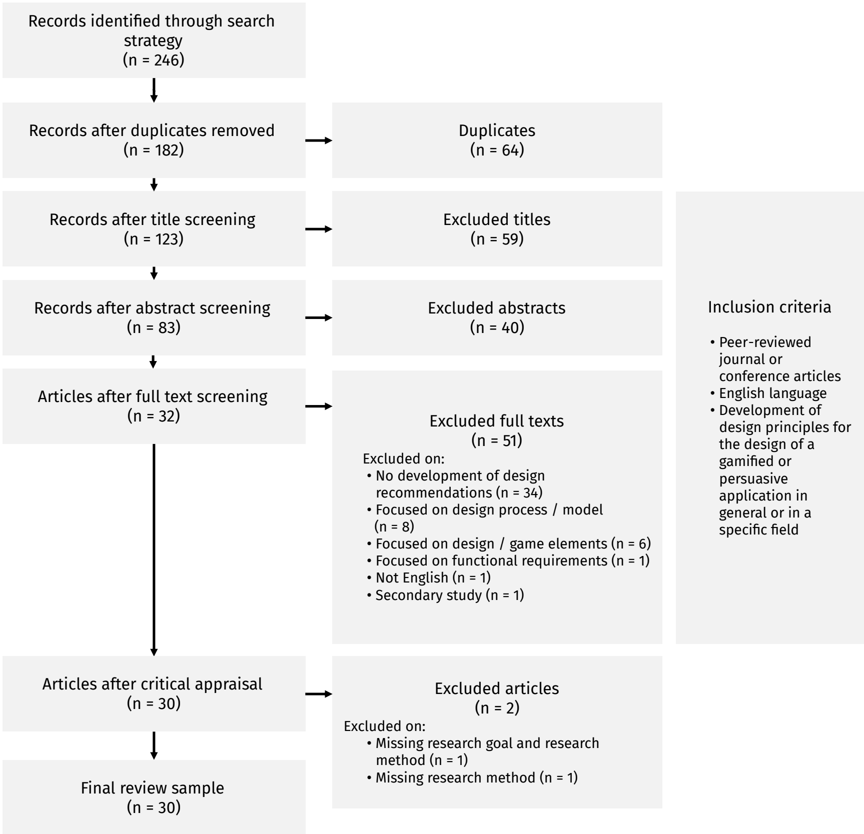


**Figure 6.1:** Flow diagram for the selection of studies in the systematic review on design principles for gamification and persuasive systems.

first quartile and 7 out 22 were published in the second quartile of their respective research area, mostly human-computer interaction, computer science, pedagogy and psychology. Most conferences were not classified in the considered rankings, despite the very renowned Hawaii International Conference on System Sciences. This may stem from the specialization of several conferences to narrow topics, such as serious games or health informatics, but does not necessarily indicate low study quality. As only peer-reviewed conference papers were considered in the final sample, a scientific approval of the articles' quality is guaranteed by all means.

The earliest design recommendations are the general persuasive strategies proposed by Oinas-Kukkonen and Harjumaa in 2009 [126], followed by several adaptations in healthcare [256], [514], [518], [519] between 2012 and 2014. Gamification design principles primarily focused on education and game-based learning until 2015 [257], [258], [520], but later expanded to sustainability [84], websites [521], IS [522], fitness [259], crowdsourcing [505], [523] and out-of-context recommendations [123], [124], [479], [481], [482]. In general, gamification design has gained academic attention in recent years. Table 6.2 illustrates the distribution of topics in the articles examined. The majority of articles use qualitative methods to derive design principles for gamification and persuasive systems. These methods consist of qualitative interviews (8 articles), case study analyses (2 articles) or participatory design (2 articles). Four studies mix several qualitative research methods, and ten studies can be classified as conceptual. Only a minority relies on quantitative analyses such as surveys (3 articles) and text mining (1 article).

[126]: Oinas-Kukkonen *et al.* (2009)

[256]: Cafazzo *et al.* (2012)
[514]: Mintz (2013)
[518]: Soror *et al.* (2014)
[519]: Vainio *et al.* (2014)

[257]: Israel *et al.* (2013)
[258]: Plass *et al.* (2015)
[520]: Wehbe *et al.* (2014)

[84]: Oppong-Tawiah *et al.* (2020)

[521]: Hsieh *et al.* (2020)

[522]: Schulz *et al.* (2019)

[259]: Kappen *et al.* (2016)

[505]: Kavaliova *et al.* (2016)
[523]: Sakamoto *et al.* (2017)

[123]: Morschheuser *et al.* (2018)
[124]: Liu *et al.* (2017)
[479]: Rapp (2017)
[481]: Chen (2019)
[482]: Rapp (2017)

**Table 6.2:** Research areas of the reviewed articles.

| Research area | No. | Articles |
|---|---|---|
| **Gamification** | **19** | |
| Education | 6 | [257], [258], [478], [510], [524], [525] |
| Crowdsourcing | 2 | [505], [523] |
| Fitness | 1 | [259] |
| Sustainability | 1 | [84] |
| Reading | 1 | [520] |
| Inf. Systems | 1 | [522] |
| Websites | 1 | [521] |
| Healthcare | 1 | [526] |
| General | 5 | [123], [124], [479], [481], [482] |
| **Persuasive systems** | **11** | |
| Healthcare | 8 | [256], [483], [514], [518], [519], [527]–[529] |
| Sustainability | 1 | [127] |
| General | 2 | [126], [128] |

### 6.4.2 Design Principles

Overall, scientists suggest 69 different design principles that should be considered when developing gamification and persuasive systems in general (Table 6.3). Half of the articles agree on the importance of *informational content*, i.e., providing background information about the goals intended by the intervention and helping users change attitudes and behaviors by providing assistance and hints. In addition, many articles suggest the introduction of *behavioral incentives*, which can be tangible (e.g., cash prizes for the winner) or intangible (e.g., collecting badges and certificates). Moreover, researchers propose to *personalize the content and mechanics of the system*, assuming that the motivational function of the various affordances depends on the user's personality or type. *Immediate positive feedback* for good performance, such as earning points, and the *ability to compare oneself with others*, such as in leaderboards, are also important principles for a successful gamification design.

In contrast, other principles suggested in individual articles, such as *supporting different roles* or *using appropriate sounds*, are not universally applicable and may be particularly valuable in certain contexts, e.g., when users with different roles (e.g., doctor and patient) use the system or when acoustic signals in the system are intended to support multi-sensory learning. It is noteworthy that some principles (e.g., *persuasive messages*) are mentioned more frequently in a particular domain (e.g., healthcare) than in others, suggesting that the choice of appropriate design principles also still depends on the application domain and intended outcomes. Table 6.3 lists all of the design principles suggested in the articles reviewed.

As Table 6.3 shows, scholars propose a variety of heterogeneous design principles for gamification and persuasive systems, some of which relate more to the content of the system (e.g., *behavioral incentives, immediate positive feedback, or persuasive messages*), while others relate to the mechanics (e.g., *increasing and adjusting the level of difficulty over time* or allowing *freedom of choice*) or the context of the intervention (e.g., *involving the target group in co-design*). To provide a comprehensive overview that can guide gamification design, the identified principles require further conceptual discussion and categorization.

Table 6.3: Design principles mentioned in the reviewed articles.

| Design principle | No. | Articles |
|---|---|---|
| Offer informational content | 15 | [84], [124], [126], [256]–[258], [483], [510], [518]–[520], [522], [525], [527], [529] |
| Introduce behavioral incentives | 13 | [124], [126], [128], [256], [258], [259], [479], [482], [505], [510], [523], [527], [529] |
| Personalize the system contents and mechanics | 12 | [124], [126], [127], [256], [257], [259], [481], [510], [518], [520], [521], [524], [526] |
| Provide immediate positive feedback | 11 | [124], [126], [128], [257], [478], [510], [518], [519], [521], [523], [527] |
| Allow social comparisons | 10 | [84], [124], [126], [128], [259], [478], [518], [523], [527], [528] |
| Frame the intervention with storytelling | 9 | [258], [479], [482], [510], [520]–[523], [529] |
| Encourage social collaboration | 8 | [84], [126], [128], [257], [478], [479], [510], [527] |
| Show how behavior relates to the goals (cause and effect) | 8 | [126], [128], [510], [518], [519], [523], [525], [527] |
| Guide users with persuasive messages | 8 | [84], [126], [256], [478], [483], [518], [527], [529] |
| Consider the context and location | 8 | [123], [124], [126]–[128], [518], [524], [527] |
| Increase and adjust difficulty over time | 7 | [128], [257], [510], [519], [521], [522], [527] |
| Allow showing status and gaining social recognition | 7 | [126], [259], [478], [479], [505], [527], [530] |
| Provide data for (self-) monitoring | 7 | [126], [256], [259], [483], [518], [520], [527] |
| Visualize progress | 7 | [259], [478], [481], [510], [519], [522], [523] |
| Divide content in tasks and steps | 6 | [126], [128], [259], [510], [519], [527] |
| Connect users for social interaction | 6 | [84], [124], [126], [259], [478], [479] |
| Enable freedom of choice | 6 | [257], [259], [478], [479], [481], [510] |
| Prioritize aesthetic design | 6 | [126], [258], [510], [521], [522], [529] |
| Include target group in co-design | 6 | [123], [257], [481], [514], [519], [524] |
| Provide community support | 6 | [124], [482], [483], [519], [523], [527] |
| Allow social competition | 6 | [84], [126], [479], [510], [527], [528] |
| Provide clear and meaningful (self-set) goals | 5 | [510], [519], [521], [523], [527] |
| Allow for the evaluation of one's own knowledge | 5 | [257], [258], [510], [519], [520] |
| Consider the ethics of design and privacy protection | 5 | [123], [126], [128], [478], [479] |
| Ensure continuous excitement with new or hidden content | 5 | [128], [481], [510], [519], [529] |
| Provide multiple paths to achieve a goal | 5 | [128], [510], [522], [525], [528] |
| Enable social learning | 5 | [84], [126], [518], [519], [527] |
| Respect the outcomes or goals targeted | 5 | [84], [123], [124], [525], [526] |
| Enable self-comparison | 4 | [479], [510], [520], [528] |
| Connect the system with other soft- and hardware | 4 | [124], [483], [510], [514] |
| Check the fit of intervention and technology | 4 | [84], [123], [510], [520] |
| Include normative influence | 3 | [84], [126], [527] |
| Set reminders | 3 | [84], [126], [510] |

Table 6.4: Design principles mentioned in the reviewed articles (continued).

| Design principle | No. | Articles |
|---|---|---|
| Provide enough content for additive motivation | 3 | [479], [521], [522] |
| Keep system persistence | 3 | [128], [482], [526] |
| Allow self-organization in groups and teams | 2 | [479], [520] |
| Communicate system credibility | 2 | [126], [527] |
| Support different roles or profiles | 2 | [520], [522] |
| Ensure fairness | 2 | [123], [528] |
| Avoid downwards comparisons | 2 | [482], [528] |
| Enable sharing of results | 2 | [256], [529] |
| Allow practice | 2 | [510], [527] |
| Introduce punishment and losing options | 2 | [482], [527] |
| Avoid penalties and allow failing | 1 | [510] |
| Ensure accessibility | 1 | [510] |
| Use fitting sounds | 1 | [510] |
| Set clear rules | 1 | [521] |
| Communicate challenges | 1 | [478] |
| Use known designs and metaphors | 1 | [127] |
| Follow an iterative design process | 1 | [123] |
| Test ideas as early as possible | 1 | [123] |
| Involve stakeholders and organizations | 1 | [123] |
| Focus on user needs during ideation | 1 | [123] |
| Manage and continuously optimize design | 1 | [123] |
| Relate to real-world experiences | 1 | [128] |
| Encourage creativity and problem-solving | 1 | [128] |
| Build a system of resources and economy | 1 | [523] |
| Foster curiosity | 1 | [523] |
| Avoid social competition | 1 | [520] |
| Allow anonymity | 1 | [520] |
| Provide social feedback | 1 | [527] |
| Avoid behavioral incentives | 1 | [481] |
| Build memories | 1 | [482] |
| Display system navigation | 1 | [257] |
| Enable routines | 1 | [259] |
| Maintain equilibrium between elements | 1 | [526] |
| Onboard first-time users | 1 | [505] |
| Check for easy usability | 1 | [483] |

## 6.5 Discussion

To the best of the author's knowledge, this is the first review work that focuses on summarizing the divergent views and recommendations of design *principles* for gamification and persuasive systems from different contexts, bridging the gap between process-oriented design methods [123], [250] and element-oriented design patterns or motivational affordances [48], [50]. A variety of more than 60 different design principles has been identified. As a first point of discussion, the analysis shows that some recommendations for the design of gamification and persuasive systems seem to be contradictory.

[123]: Morschheuser *et al.* (2018)
[250]: Mora *et al.* (2017)

[48]: Koivisto *et al.* (2019)
[50]: Hamari *et al.* (2014)

For example, some scientists argue against punishment and for the motivational nature of safe environments [510], while others favor losing options to exert pressure for behavioral change [255], [482], in line with behaviorist theories of positive and negative reinforcement [375]. Thus, I suggest that

[510]: Sezgin *et al.* (2020)

[255]: Wang *et al.* (2019)
[482]: Rapp (2017)

[375]: Skinner (1953)

the important aspect of co-designing the intervention with the target group [123], [257], [481], [514], [519], [524] should include discussing whether losing options are perceived as a barrier or facilitator of motivational effects.

[123]: Morschheuser *et al.* (2018)
[257]: Israel *et al.* (2013)
[481]: Chen (2019)
[514]: Mintz (2013)
[519]: Vainio *et al.* (2014)
[524]: Gooch *et al.* (2015)

Negative and positive reinforcements, such as rewards, represent external events as stated in cognitive evaluation theory [337] that can undermine intrinsic motivation [367], which is why Chen [481] argues that behavioral incentives should be avoided. In contrast, a large number of the reviewed studies strongly suggest the introduction of behavioral incentives, not only conceptually, but also backed up by qualitative interviews [259], [510], [529] and quantitative surveys [128] that emphasize their motivational power. Since tangible extrinsic incentives, such as money, can pose the crucial challenge of influencing behavior only as long as they are available [261], implementing intangible incentives such as achievements and badges that could be more efficient than tangible prizes.

[337]: Deci *et al.* (1985)

[367]: Deci *et al.* (1999)

[259]: Kappen *et al.* (2016)
[510]: Sezgin *et al.* (2020)
[529]: Vilardaga *et al.* (2018)

[128]: Orji *et al.* (2019)

[261]: Ryan *et al.* (2017)

Moreover, Wehbe et al. [520] suggest avoiding social competition, whereas other scholars strongly favor social competition mechanisms [84], [126], [128], [255], [479], [510]. Social comparison theory [389] underlines the introduction of comparison and competition mechanisms as a motivational drive for self-evaluation through comparison with others. However, it is suggested that interventions should be carefully designed to ensure that people do not perceive a high risk of exposing their own inferiority to others [390].

[520]: Wehbe *et al.* (2014)

[84]: Oppong-Tawiah *et al.* (2020)
[126]: Oinas-Kukkonen *et al.* (2009)
[128]: Orji *et al.* (2019)
[255]: Wang *et al.* (2019)
[479]: Rapp (2017)

[389]: Festinger (1954)

[390]: Buunk *et al.* (2007)

Second, as indicated in the results section, the proposed principles relate to different aspects of gamification and persuasive system design. Designing a positive user experience usually depends on three elements: the user, the system, and the context [531]. In conceptualizing the identified design principles, I argue that they can be distinguished into *user-oriented principles* that drive user behavior, *system-oriented principles* that relate to the mechanisms that lead to hedonic experiences or affective reactions such as enjoyment and satisfaction, and *context principles* that refer to the context of the intervention. User-oriented and system-oriented principles, in particular, can guide the choice of interface design patterns or motivational affordances. To better illustrate the link between design principles and motivational affordances, I suggest examples from the variety of motivational affordances proposed in the academic literature [48], [50], [532] that can be selected to implement specific design principles. As can be seen in the examples, a particular affordance can serve to implement multiple design principles, in line with the observations of Deterding [245], e.g. achievements visualize one's own progress for the intrinsic need of competence [261] and constitute an incentive [337], while peer-rating provides community support and allows social recognition.

[531]: Lallemand *et al.* (2015)

[48]: Koivisto *et al.* (2019)
[50]: Hamari *et al.* (2014)
[532]: Tondello *et al.* (2017)

[245]: Deterding (2014)

[261]: Ryan *et al.* (2017)

As a result, I propose a conceptual framework of design principles for the successful design of gamification and persuasive systems (Figure 6.2) that comprises the most substantiated design principles considered important by at least five of the reviewed articles and examples of their implementation with motivational affordances.

*User-oriented principles* are those principles that lead to both *individual* and *social* behavior outcomes. For example, providing immediate positive feedback (e.g., with points and badges), introducing incentives (e.g., rewards) or guiding with persuasive messages (e.g., reminders and suggestions) directly induce individual user behavior towards intended outcomes.

Context of the intervention

Gamified system

*User-oriented principles for behavioral outcomes*

| **Individual behavior principles** | **Exemplary patterns / motivational affordances** |
|---|---|
| Provide immediate positive feedback | Points, badges, levels, performance stats, progress |
| Introduce behavioral incentives | Achievements, rewards (in-game and real-world) |
| Offer informational content | Quizzes, assistance, reminders, virtual helpers |
| Frame the intervention with storytelling | Narrative, avatar, role play |
| Divide content in tasks and steps | Challenges, missions |
| Guide users with persuasive messages | Reminders, cues, suggestions |
| Provide data for (self-)monitoring | Tracking, performance stats |
| Visualize progress | Levels, status bars, achievements, badges |
| Provide clear and meaningful (self-set) goals | Tasks, goal setting, clear goals |
| Allow for the evaluation of one's own knowledge | Quizzes, questions |
| Show how behavior relates to the goals | Impact visualizations, performance stats |

| **Social behavior principles** | **Exemplary patterns / motivational affordances** |
|---|---|
| Allow social comparisons | Leaderboards, rankings |
| Encourage social collaboration | Multiplayer, teams, collective voting |
| Connect users for social interaction | Social networking features, teams |
| Allow showing status and gaining social recognition | Peer-rating, profile, medals, trophies |
| Allow social competition | Challenges, leaderboards |
| Enable social learning | Knowledge sharing (forums) |
| Provide community support | Knowledge sharing (forums), peer-rating, praise |

*System-oriented principles for hedonic experiences and affective reactions*

| **Hedonic experience principles** | **Exemplary patterns / motivational affordances** |
|---|---|
| Personalize the system contents and mechanics | Avatar, character, virtual identity, customization |
| Increase and adjust difficulty over time | Levels, skill trees, increasing difficulty, timer |
| Enable freedom of choice | Missions, challenges, anarchic gameplay |
| Ensure continuous excitement with new or hidden content | Unlockable content, easter eggs, narrative |
| Provide multiple paths to achieve a goal | Challenges, missions, nonlinear gameplay |

*Context principles*

Consider the context and location of the intervention
Include target group in co-design
Prioritize aesthetic design
Consider the ethics of design, privacy protection and trustworthiness
Respect the outcomes or goals targeted

Figure 6.2: Framework of design principles for gamification and persuasive systems.

Providing informational content (e.g., in the form of reminders and virtual helpers) and dividing the content into tasks and steps (e.g., with challenges or missions) can help individuals acquire the knowledge they need to change their behavior in the desired way. On the other hand, allowing social comparisons (e.g., with leaderboards), encouraging collaboration (e.g., with teams) or connecting users for social interaction (e.g., with social networking features) lead to a community drive towards individual behavior change.

*System-oriented principles* include design principles that promote hedonic experiences. For example, personalization of the system (e.g., with avatars and customization) promotes the identification with the system, and freedom of choice (e.g., different missions) leads to enjoyment.

*Context principles* refer to the context of the intervention, such as considering the location and goals of the intervention, respecting the ethics of design, protecting privacy and trustworthiness, or involving the target group in co-design.

## 6.6 Implications

The foregoing review and discussion constitute the first to focus on the current state of knowledge regarding design principles for the successful design of gamification and persuasive systems. It can be seen that empirical research has identified a variety of design principles in different areas, with the articles seeming to agree on some crucial user-oriented, system-oriented and context principles that should be considered in the design of gamification and persuasive systems. On the other hand, some suggestions seem to be contradictory and warrant further investigation. The findings provide valuable guidance for further research as well as for the practical design and use of gamification in various application contexts.

### 6.6.1 Implications for Theory

The present review has identified important principles for the successful design of gamification and persuasive systems that are largely supported by theory. For example, from the perspective of goal-setting theory, immediate positive feedback and adapted difficulty are critical moderators for successful goal achievement [358]. In addition, incorporating social comparisons can facilitate upward comparisons [389] and, along with social collaboration, support vicarious learning [329], which in turn can increase individuals' self-efficacy [352] in achieving the goals targeted by the intervention.

[358]: Locke *et al.* (2013)

[389]: Festinger (1954)

[329]: Bandura (2001)

[352]: Bandura (1982)

However, the results also reveal contradictions among design principles that can be discussed in light of the theory. For example, reinforcement theory [375], as a behaviorist view of behavior, supports external positive and negative reinforcements, whereas cognitive evaluation theory [337], as a cognitive view of behavior, portrays the perception of such external reinforcements as controlling. This, in turn, might conflict with the need for autonomy [261] and thereby undermine intrinsic motivation [367]. Clearly, more theory-driven and comparative empirical research is needed to explore and understand the ways in which different designs influence user perceptions and effectiveness in the specific context of gamification.

[375]: Skinner (1953)

[337]: Deci *et al.* (1985)

[261]: Ryan *et al.* (2017)

[367]: Deci *et al.* (1999)

In addition, empirical research points to design principles that emerge from practical observations of work with users and organizations that complement how theoretical considerations might be implemented. For example, framing the intervention with storytelling may be an appropriate approach to designing guided paths that enable constructivist learning [338], [339] and allow users to experiment with different options in a story to achieve their goal, thereby fostering experiential learning [501]. In addition, the design principles identified highlight the importance of context principles that go beyond psychological processes, such as involving the target audience in co-design and considering the ethics of design and

[338]: Vygotsky (1978)

[339]: Jonassen (1999)

[501]: Kolb *et al.* (2013)

privacy. The relationship between theoretical considerations and empirically identified design principles needs further exploration to understand how and why such design principles are essential and effective from a theoretical perspective to achieve desired outcomes.

### 6.6.2 Implications for Practice

The identified design principles provide valuable guidance for future practical endeavors in gamification and persuasive system design. In particular, the categorized design principles can help practitioners bridge the gap between the abstract game design method they follow as well as the game design model they have defined and the selection of concrete motivational affordances in their intervention.

With respect to the game design model, e.g., in the form of the MDA model, the framework of design principles related to dynamics can help in selecting appropriate mechanics (i.e., motivational affordances) to achieve the intended aesthetics or emotional response [254]. With respect to various game design methods that share the common steps of defining goals and expected behaviors, identifying player types, and then applying appropriate game design principles [250], the developed framework can assist in identifying appropriate user- and system-oriented design principles for the goals.

[254]: Hunicke *et al.* (2004)

[250]: Mora *et al.* (2017)

For example, knowledge evaluation may be highly relevant in educational contexts, whereas it may be negligible in fitness contexts. Or social collaboration may be very relevant in contexts where users know each other, such as in companies, while it may not be the best approach in individualistic contexts where users have no relationships and use the intervention mainly for themselves, such as in mindfulness applications. Overall, the contextual principles emphasize the importance of interaction and co-design with the target audience to achieve a successful gamification design.

## 6.7 Conclusion and Limitations

With the increasing divergence of gamification and persuasive systems in diverse areas, various design principles have been proposed. This systematic review has identified more than 60 different principles in primary research studies, which can be divided into user-oriented principles to achieve the intended behavior, system-oriented principles to ensure a hedonic user experience, and context principles and can guide future research and practice towards successful gamification design.

However, this study is not without limitations. While this work aimed to provide a generic overview of design principles for the design of gamification and persuasive systems from the academic literature, it neglected the design experiences of practitioners, which could also be considered valuable for deriving effective design principles. Further work is invited to expand the review with books, reports, and other sources of practitioners to verify consistency with the principles drawn from the scientific literature.

Since this review, to the best of the author's knowledge, represents the first systematic analysis of design principles in gamification and persuasive systems, the identification and classification of design principles was based primarily on my own assessment of the similarities and differences between the principles proposed in the reviewed articles (e.g., "immediate feedback", "positive feedback", and "feedback mechanisms" were combined into "immediate positive feedback"). I, therefore, encourage further research to repeat or expand the review to verify the reliability of the design principles.

Finally, the selection of appropriate design principles for a given application context should be facilitated by empirically comparing the effectiveness of different principles in diverse areas, uncovering the most important principles for specific contexts, such as, but not limited to, education, business, sustainability, healthcare, and fitness, which are among the most popular in current research on gamification and persuasive systems.

The preceding review of design principles for gamification and persuasive systems led to the following key insights for the design of the gamified app in the first DSR cycle:

- There are many different design principles from various contexts that may be appropriate for successful gamification design
- The identified design principles can be divided into user-oriented individual and social behavioral principles that support desired behavioral outcomes, systems-oriented principles that support hedonic experiences and positive affective responses, and context principles that emphasize critical considerations of the intervention's goals, setting, and target audience
- Some of the principles are contradictory, and theoretical considerations can help in deciding which principles to follow in a particular context
- User and system-oriented principles can be mapped to exemplary motivational affordances to translate abstract considerations into concrete gamification design (illustrated in Figure 6.2)

Together with the theoretical principles identified through the systematic review in Chapter 5, the identified principles form the basis for the development of the first prototype of the envisioned gamified application.

# First DSR Cycle: Click Dummy Development and Formative Evaluation

# 7 Click Dummy Development of a Gamified App for Sustainable Employee Behavior



## 7.1 Definition of Objectives/Suggestion

The preceding consideration of both theoretical foundations in research on gamification, serious games, and game-based learning and empirical recommendations on design principles for gamification and persuasive systems contributed to a well-established theoretical knowledge base to build the artifact, i.e., a click dummy of the envisioned gamified application for sustainable employee behavior, in the first DSR cycle.

Following the DSR paradigm, the first step in the DSR cycle is to formulate objectives and suggestions for the artifact as a basis for subsequent design and development. In this context, *user stories* provide a means to express expected system goals and functionality in semi-structured natural language from the user's perspective [533]. They describe valuable system functionality from the user's point of view [534] and are particularly useful for developing needed system functionality and bringing a customer-centric perspective to the overall development process [533], as they allow user expectations to be defined and then optionally further subdivided into system requirements [534].

[533]: Amna *et al.* (2022)

[534]: Savolain *et al.* (2010)

[535]: Lucassen *et al.* (2016)
[536]: Cohn (2009)

**A note on user stories.**

User stories are most often formulated [535] using the Connextra template [536]: *"As a <role>, I want <goal>, [so that <benefit>]"*. The template can also be adapted to exclude the benefit part [535]. Since in this work the benefit is defined in such a way that it fulfills the theoretical principles, the Connextra template is used in the shortened form.

Accordingly, the identified theoretical and empirical design principles are translated into 18 user stories for the design and development of the proposed gamified application for sustainable employee behavior, as summarized in Table 7.1 and Table 7.2.

Careful consideration of the preceding results reveals that the identified principles both from theory and empirical research follow similar categorizations related to the general aspects of user experience in motivational IS [249] that influence attitudes toward a system and behavioral intentions to use the system: *utilitarian* aspects, *hedonic* aspects, and *social* aspects. The principles categorized as "Principles that guide towards the intended behavioral outcomes" (Chapter 5) or "User-oriented individual behavior principles" (Chapter 6) aim to satisfy utilitarian aspects of the user experience, i.e., the perception of the extent to which the system enhances or supports the performance of a task [249]. Second, principles called "Principles that enable social interaction and positive social effects" (Chapter 5) or "User-oriented social behavior principles" (Chapter 6) help fulfill the social aspect of the user experience, which includes social influence and relatedness [249]. Finally, "Principles that foster individual relevance" (Chapter 5) or "System-oriented principles for hedonic experiences and affective reactions" (Chapter 6) intend to promote the hedonic aspect of the user experience, which refers to experiencing pleasure when using a system [249]. The additional "Context principles" (Chapter 6) identified in the empirical review are left out of this consideration, as they do not relate to the functionalities of the system, but rather to the process of system design. To ensure that the envisioned gamified application does not focus solely on utilitarian aspects, but also includes social and hedonic design

[249]: Hamari *et al.* (2015)

Table 7.1: Summary of the theoretical and empirical design principles identified in the previous systematic reviews and the derived user stories - utilitarian principles.

| Theoretical principles (Chapter 5) | Design principles (Chapter 6) | Derived user stories |
|---|---|---|
| **Utilitarian:** (User-oriented individual) principles that guide towards the intended behavioral outcomes | | |
| **P1: Clear and relevant goals.** Gamification can transparently illustrate goals and their relevance. | Provide clear and meaningful (self-set) goals | **US1:** As a user, I want to set goals for sustainable behavior. |
| **P3: Immediate feedback.** Gamification can provide users with direct feedback on their actions. | Provide immediate positive feedback | **US2:** As a user, I want to get a positive feedback message when I behave sustainably. |
| | Provide data for (self-)monitoring | **US3:** As a user, I want to gain points when I behave sustainably. **US4:** As a user, I want to see how much points I earned in different categories. |
| | Visualize progress | **US5:** As a user, I want to see my progress in a level system. |
| **P4: Positive reinforcement.** Gamification can reward users for their performance and communicate the relevance of their achievements. | Introduce behavioral incentives | **US6:** As a user, I want to earn badges for specific achievements. |
| | Show how behavior relates to the goals (cause and effect) | **US7:** As a user, I want to see the impact of my behavior. |
| **P8: Guided paths.** Gamification can nudge users towards the actions necessary for achieving the goals. | Guide users with persuasive messages | **US8:** As a user, I want to receive notifications and reminders that nudge me towards sustainable behavior. |
| | Frame the intervention with storytelling | **US9:** As a user, I want to get guided which actions I can take to achieve my goals. |
| | Allow for the evaluation of one's own knowledge | |
| **P10: Simplified user experience.** Gamification systems are usually easy to use and can simplify content. | Offer informational content | **US10:** As a user, I want to receive tips on how to behave sustainably. |

features to stimulate social influence and positive affect and activate hedonic and normative goal frames [133], all identified principles are prioritized equally in the specification of user stories for the envisioned application. The derivation of each user story is explained in detail below.

[133]: Lindenberg *et al.* (2013)

Regarding utilitarian principles, the first theoretical principle proposed in the previous review is that of "clear and relevant goals". Gamification works effectively when the goals and their relevance are clearly presented, which corresponds to the empirical design principle of "providing clear and meaningful (self-set) goals". Recognizing the users' need for autonomy [261], the self-setting aspect of the empirical design principle, which is also reflected in the hedonic theoretical principle of "individual goals", is included in the definition of the corresponding user story:

[261]: Ryan *et al.* (2017)

**US1:** As a user, I want to set goals for sustainable behavior.

Second, theory emphasizes the importance of "immediate feedback" about users' actions. This particular theoretical principle can be applied to several design principles from empirical research. On the one hand, "immediate positive feedback" refers to the active feedback aspect of system design in the form of a message or notification once a user has behaved in the intended manner. The corresponding user story is:

**US2:** As a user, I want to get a positive feedback message when I behave sustainably.

On the other hand, feedback can also be provided in a passive form, which is expressed by the design principles "providing data for (self-)monitoring" and " visualizing progress". In this case, the system does not provide "active" feedback to the user, but users can self-supervise their progress, which is provided "passively" by the system. There are several game elements that can be used to illustrate progress (Chapter 6), of which points and levels have been selected in this artifact because they are commonly used in gamified systems to illustrate progress [48]. Thus, the third user story is:

[48]: Koivisto *et al.* (2019)

**US3:** As a user, I want to gain points when I behave sustainably.

Since the proposed application is intended to incorporate various categories of sustainable employee behavior in accordance with the SDGs targeted by this research project to expand the focus of previous studies (Chapter 4), the previous user story is augmented by the following user story to provide more granular feedback on user actions:

**US4:** As a user, I want to see how much points I earned in different categories.

In addition, to provide meaning to the point system and to reflect the principle of "visualizing progress," the following user story is included in the set of feedback-related user stories:

**US5:** As a user, I want to see my progress in a level system.

Third, theory has emphasized the importance of "positive reinforcements", meaning that the system rewards users for their performance and conveys the importance of their accomplishments. This theoretical principle involves two distinct aspects, reflected in two design principles. First, the principle of "introducing behavioral incentives" refers to the reward itself. Rewards can be provided in the form of achievements in the game or as a real-world incentives (Chapter 6). Due to the intervention context, in which the barriers for companies to use the envisioned gamified application for sustainable employee behavior should be kept as low as possible, virtual (and thus gratuitous) rewards are chosen to address these principles. The user story is formulated as follows:

**US6:** As a user, I want to earn badges for specific achievements.

On the other hand, the principle of "showing how behavior relates to goals (cause and effect)" corresponds to the relevance of the achievements made by the user. Instead of just offering a virtual reward, users should also be shown how their individual behavior and contributions are relevant to sustainable development. This results in the following user story:

**US7:** As a user, I want to see the impact of my behavior.

In addition, theory highlights the importance of providing ”guided paths” so that the gamified system encourages users to take the actions necessary to achieve their goals. Several design principles from empirical research are related to the idea of guidance: ”guide users with persuasive messages”, ”frame the intervention with storytelling”, and ”allow for evaluation of one’s knowledge” all relate to aspects of guiding users on how to behave sustainably in the workplace to achieve their goals, whether in the form of messages, predefined paths, or quizzes that impart knowledge. To address the persuasive message aspect, the following user story is formulated:

**US8:** As a user, I want to receive notifications and reminders that nudge me towards sustainable behavior.

To address the aspects of defined pathways to sustainable behavior and knowledge delivery, an additional user story is included:

**US9:** As a user, I want to get guided which actions I can take to achieve my goals.

As a final theoretical principle related to utilitarian aspects of the user experience, theories emphasize the importance of ”simplifying user experience” and content, which can be related to the design principle of ”providing informational content.” Instead of supplying users with lots of textual information about sustainability, the idea is to break down the complex topic of sustainable behavior into concrete, easy-to-understand nuggets of information. Accordingly, the user story is formulated as follows:

**US10:** As a user, I want to receive tips on how to behave sustainably.

In the case of the principles relating to the social aspects of the user experience, a distinction can be made primarily between collaborative and competitive principles. The theoretical principle of ”social comparisons” includes both the design principles of ” allowing social comparisons” and ”allowing social competition”. Although similar, social comparisons can include multiple levels of comparison that users can choose for themselves, based on performance, level, or other dimensions that may be of individual interest. To enable such *individually chosen* comparisons, the following user story is expressed:

**US11:** As a user, I want to see other users’ profiles.

In contrast, social competition refers to a direct comparison of multiple users at predefined levels, such as points accumulated in a leaderboard or in a challenge. To accommodate this *standard* aspect of comparison, the following user story is added:

**US12:** As a user, I want to see how I perform in comparison to others.

Table 7.2: Summary of the theoretical and empirical design principles identified in the previous systematic reviews and the derived user stories - social and hedonic principles.

| Theoretical principles (Chapter 5) | Design principles (Chapter 6) | Derived user stories |
|---|---|---|
| **Social:** (User-oriented social) principles that enable social interaction and positive social effects | | |
| **P5: Social comparisons.** Gamification can allow users to see their peer's performance. | Allow social comparisons | **US11:** As a user, I want to see other users' profiles. |
| | Allow social competition | **US12:** As a user, I want to see how I perform in comparison to others. |
| **P6: Social norming.** Gamification can connect users to support each other and work towards a common goal. | Encourage social collaboration<br>Enable social learning<br>Connect users for social interaction<br>Provide community support | **US13:** As a user, I want to organize myself with colleagues in teams. |
| | Allow showing status and gaining social recognition | **US14:** As a user, I want to customize my presentation. |
| **Hedonic:** (System-oriented) principles that foster individual relevance | | |
| **P2: Individual goals.** Gamification can allow users to set their own goals. | Provide clear and meaningful (self-set) goals | **US1:** As a user, I want to set goals for sustainable behavior. |
| | Personalize the system contents and mechanics | **US15:** As a user, I want to be able to make personal settings for the applications' functionalities. |
| **P7: Adaptive content.** Gamification can adapt tasks and complexity to the abilities and knowledge of the user. | Divide content in tasks and steps | **US16:** As a user, I want to unlock new content when I progress in the application. |
| | Increase and adjust difficulty over time | **US17:** As a user, I want to see continuous new content in the application. |
| | Ensure continuous excitement with new or hidden content | |
| **P9: Multiple choices.** Gamification can allow users to choose between several different options to achieve a certain goal. | Enable freedom of choice<br>Provide multiple paths to achieve a goal | **US18:** As a user, I want to choose from different actions that I can perform for sustainability. |

In terms of collaboration, the theoretical principle of "social norming" refers to connecting users to support each other and work toward common goals, which includes design principles such as "fostering social collaboration", "enabling social learning", "connecting users for social interaction", and "providing community support." Although various game elements can provide a sense of relatedness and mutual support, teams are one of the most important social elements [48] because they enable both collaboration, interaction, and social learning. Correspondingly, the user story is:

[48]: Koivisto *et al.* (2019)

**US13:** As a user, I want to organize myself with colleagues in teams.

The design principle of "showing status and gaining social recognition" echoes another aspect of "social norming" that focuses on normative social influence rather than relatedness, but is equally important in fostering social experiences [249]. Therefore, the following user story is appended:

[249]: Hamari *et al.* (2015)

**US14:** As a user, I want to customize my presentation.

The first principle that relates to hedonic aspects of the user experience is the principle of "individual goals," which has already been partially considered in US1. However, the design principle of "personalizing the system contents and mechanics" adds another aspect of individualization beyond goal setting that should be considered for hedonic experiences. The corresponding user story is:

**US15:** As a user, I want to be able to make personal settings for the applications' functionalities.

Moreover, the theoretical principle of "adaptive content" includes the idea of several design principles derived from empirical research, such as "dividing content into tasks and steps", "increasing and adjusting difficulty over time", and "ensuring continuous excitement with new or hidden content", the former referring to a more transparent way of dividing content defined by user progress, while the latter also includes the aspect of exploration and recurrent surprise. To address these two aspects, the following user stories are derived:

**US16:** As a user, I want to unlock new content when I progress in the application.

**US17:** As a user, I want to see continuous new content in the application.

Finally, the theoretical principle of "multiple choices" refers to the design principles of "enabling freedom of choice" and "providing multiple paths to achieve a goal" and essentially results from central findings of experiential learning [452]. Transferred to the objective of sustainable employee behavior, the final user story is formulated:

[452]: Kolb (1984)

**US18:** As a user, I want to choose from different actions that I can perform for sustainability.

## 7.2 Click Dummy Design and Development

Based on the user stories derived from the theoretical knowledge base, design and development in the first DSR cycle includes the design of an artificial artifact that is intended to provide insights into the design hypotheses and a basis for discussing the artifact with the target audience [103]. Mock-ups or wireframes as a form of user interface prototypes have proven to be particularly suitable for illustrating the envisioned system functionality to end users without investing too much upfront development time [537]. To this end, several mock-ups of different design features are designed to implement the defined user stories in Adobe XD and, to give employees a sense of the expected functionality in the initial DSR evaluation, are linked in the form of a click dummy that illustrates the actual usage behavior of the gamified application.

**Adobe XD.**

Adobe XD is a prototyping software that allows to easily build user interface prototypes with auto-animation: https://www.adobe.com/de/products/xd/solutions/web-design-software.html

[103]: Venable *et al.* (2016)

[537]: Rivero *et al.* (2014)

Based on the context of the intervention, the format of a smartphone application is chosen that could be easily used by all employees on their

Table 7.3: User stories and their implementation in the click dummy.

| User story | Related implementation |
| --- | --- |
| **Utilitarian:** User stories that guide towards the intended behavioral outcomes | |
| **US1:** As a user, I want to set goals for sustainable behavior. | Figure 7.1 |
| **US2:** As a user, I want to get a positive feedback message when I behave sustainably. | Figure 7.3 |
| **US3:** As a user, I want to gain points when I behave sustainably. | Figure 7.3 |
| **US4:** As a user, I want to see how much points I earned in different categories. | Figure 7.3 |
| **US5:** As a user, I want to see my progress in a level system. | Figure 7.3 |
| **US6:** As a user, I want to earn badges for specific achievements. | Figure 7.4 |
| **US7:** As a user, I want to see the impact of my behavior. | Figure 7.3, Figure 7.4 |
| **US8:** As a user, I want to receive notifications and reminders that nudge me towards sustainable behavior. | Figure 7.2 |
| **US9:** As a user, I want to get guided which actions I can take to achieve my goals. | Figure 7.2 |
| **US10:** As a user, I want to receive tips on how to behave sustainably. | Figure 7.2 |
| **Social:** User stories that enable social interaction and positive social effects | |
| **US11:** As a user, I want to see other users' profiles. | Figure 7.5 |
| **US12:** As a user, I want to see how I perform in comparison to others. | Figure 7.1, Figure 7.5, Figure 7.6 |
| **US13:** As a user, I want to organize myself with colleagues in teams. | Figure 7.1, Figure 7.6 |
| **US14:** As a user, I want to customize my presentation. | Figure 7.5 |
| **Hedonic:** User stories that foster individual relevance | |
| **US15:** As a user, I want to be able to make personal settings for the applications' functionalities. | Figure 7.7 |
| **US16:** As a user, I want to unlock new content when I progress in the application. | Figure 7.4 |
| **US17:** As a user, I want to see continuous new content in the application. | Figure 7.4 |
| **US18:** As a user, I want to choose from different actions that I can perform for sustainability. | Figure 7.7 |

mobile phones without requiring the company's IT department to install a new system on their corporate devices. In the following, I will explain how the individual user stories summarized in Table 7.3 are considered in the design of the click dummy. Since the target companies of this research project are located in Germany, the click dummy was developed in German.

US1: *As a user, I want to set goals for sustainable behavior* is implemented in the form of sustainable behavior challenges. As can be seen on the left side of Figure 7.1, the proposed application provides users with different challenges to select from, such as a "water challenge", presented in five different categories to address multiple dimensions of sustainable behavior: waste reduction, energy consumption, water consumption, emissions reduction, and nutrition. There are three types of challenges: individual challenges (for own goals, US1), competitive challenges (for direct comparison, US12) and collaborative challenges (for teams, US13). By clicking on a challenge (right side of Figure 7.1), the user can see details about a challenge with an illustrative image, a title, a brief description of the challenge (e.g., "Can we save 100 kWh of energy in one week?"), the current participants, and an illustration of the goal to be achieved.

In order to contribute towards mastering the challenges and thereby achieving the goals they have set themselves, the application is designed to pro-

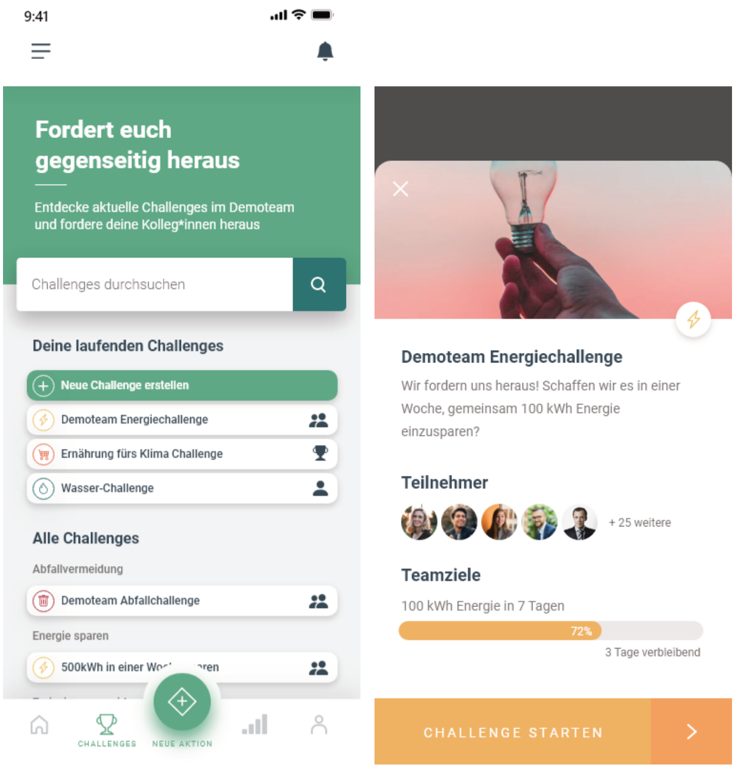


Figure 7.1: Mock-ups related to setting goals for sustainability (**US1**, **US12**, **US13**).

vide users with suggestions for sustainability actions related to their active challenges that they can perform in their day-to-day work (right side of Figure 7.2). In this way, the application provides guidance on what actions users can take to achieve their goals (**US9**). In addition, the screen on the left side of Figure 7.2 illustrates how the application provides users with reminders to prompt sustainable behavior (**US8**) and tips for sustainable behavior (**US10**) in the form of a notification system that can be accessed by clicking on the bell icon in the upper right corner of the application.

As for immediate feedback, **US2:** *As a user, I want to get positive feedback when I behave sustainably* is implemented in the form of an overlay that appears when a user performs one of the suggested actions (left side of Figure 7.3). The overlay not only contains a positive motivational message ("Nice!"), but also directly displays how much of the respective key metric, e.g. energy, the user has saved and how many points they have earned by performing the action (**US3**). Furthermore, the overlay shows how far the user has advanced in the level system (**US5**). A personal profile (right side of Figure 7.3) displays more information about the user's performance. To enable self-monitoring, the individual profile illustrates current progress in the level system (**US5**) and shows how many key metrics the user has saved (**US7**) and how many points the user has accumulated in the different categories of sustainable behavior (**US4**).

**US6** and **US7**, which refer to users' achievements in sustainable behavior and the communication of their relevance, are realized in two ways. First, as seen on the left side of Figure 7.4, users can find an area called "Achievements" in their profile where they can earn badges as virtual rewards for certain accomplishments, such as performing sustainability actions for several days in a row or reaching milestones in different categories. Users can equip these badges on their profile to show their achievements to others

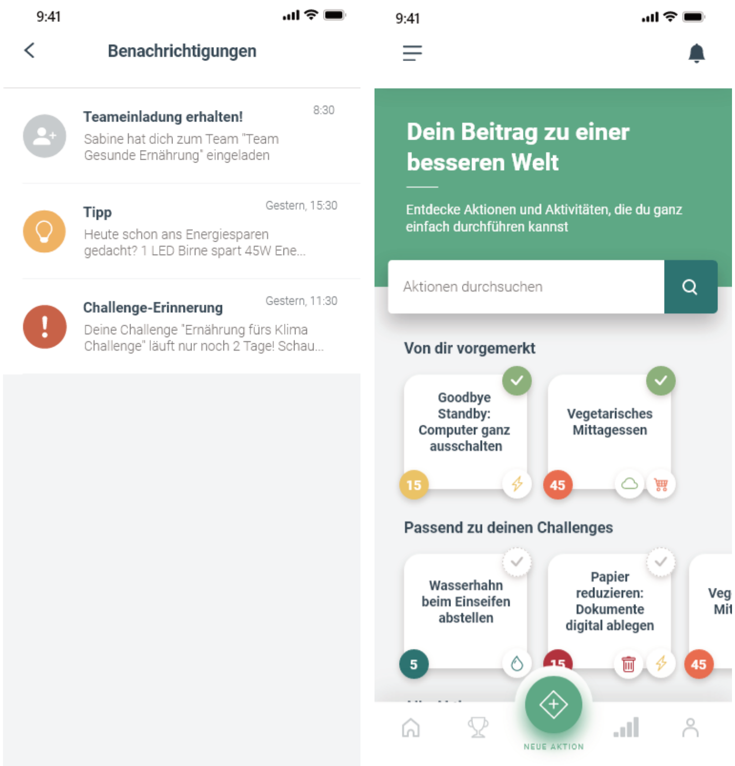


Figure 7.2: Mock-ups related to notifications, tips and guidance (US8, US9, US10).

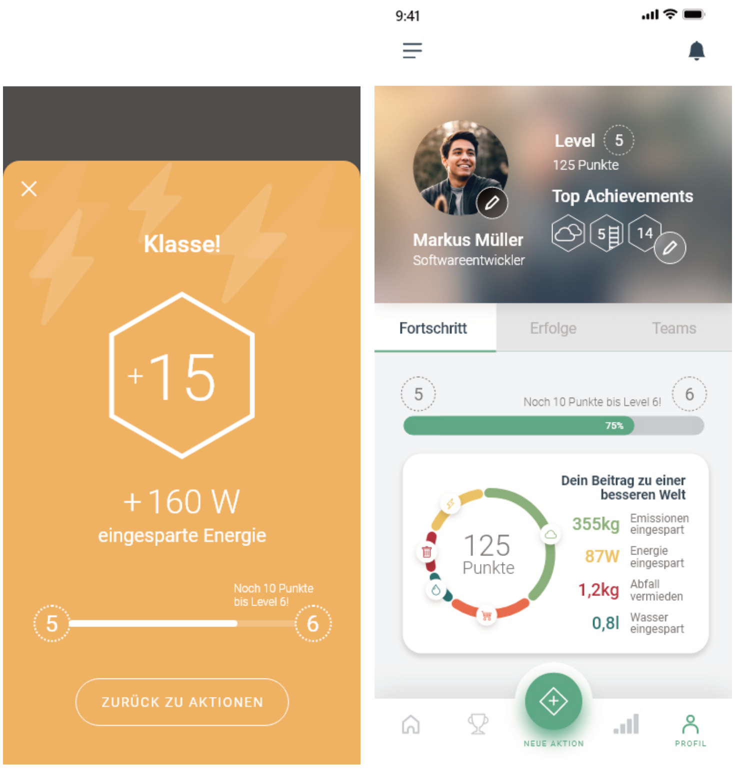


Figure 7.3: Mock-ups related to providing immediate feedback (US2, US3, US4, US5).

(US14). In addition, because the modeling software does not allow ”events” or ”pop-ups” to appear without a specific navigational click by the user, employees evaluating the design are told that they will unlock new (and more difficult) actions for sustainability by reaching certain milestones (US16 and US17). Second, to illustrate the relevance of users' individual sustainable behaviors (US7), a dashboard is displayed on the application's home page (right side of Figure 7.4) indicating how many key metrics the entire staff has already saved through their behaviors, illustrating the significant cumulative amount of individual contributions.

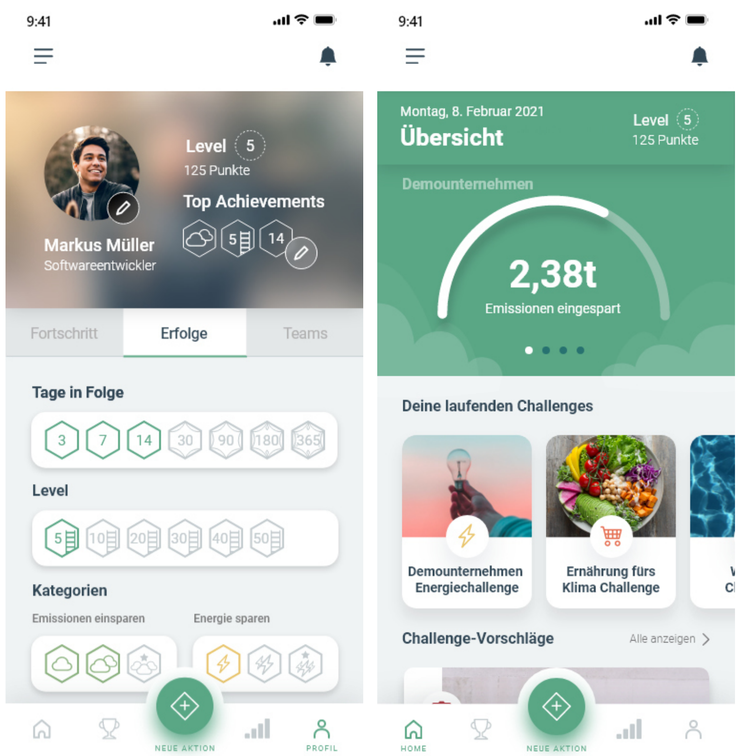


**Figure 7.4:** Mock-ups related to achievements and their relevance (US6, US7, US14, US16, US17).

Illustrating how the application enables social comparison with both user profiles (**US11**) and direct comparison (**US12**), the left side of Figure 7.5 shows how users can see other users' profiles. In particular, users can see the profile picture, name, title, level, points, and badges of other users. In their own profile, users can adjust this information to customize their presentation to others (**US14**). In addition, they can see which teams and which challenges the other user shares with them. For direct comparison (**US12**), the application offers two options. On the one hand, users can compare their points with others on a company-wide leaderboard, as shown on the right side of Figure 7.5, displaying only the top 10 to avoid negative effects of downward comparisons [389]. On the other hand, users can participate in a competitive challenge to measure their performance with selected peers on a specific topic over a period of time (shown on the left side of Figure 7.6).

[389]: Festinger (1954)

In relation to **US13:** *As a user, I want to organize myself with colleagues in teams*, the mock-up on the right side of Figure 7.6 shows an example of a team of users. Users can create or join teams by navigating to the appropriate section of their profile (left side of Figure 7.4). A team consists of a team image, title, description, and multiple members who contribute to the team statistics displayed on the team page. In this way, users can work together to save key metrics and earn points in various categories. By looking at other team pages, teams can also compare themselves.

Finally, to accommodate personalization (**US15**), the application offers the possibility to set one's own preferences on system behavior, e.g. by deciding which notifications the application is allowed to send (shown on the left


Figure 7.5: Mock-ups related to individual presentation and social comparison (US11, US12, US14).

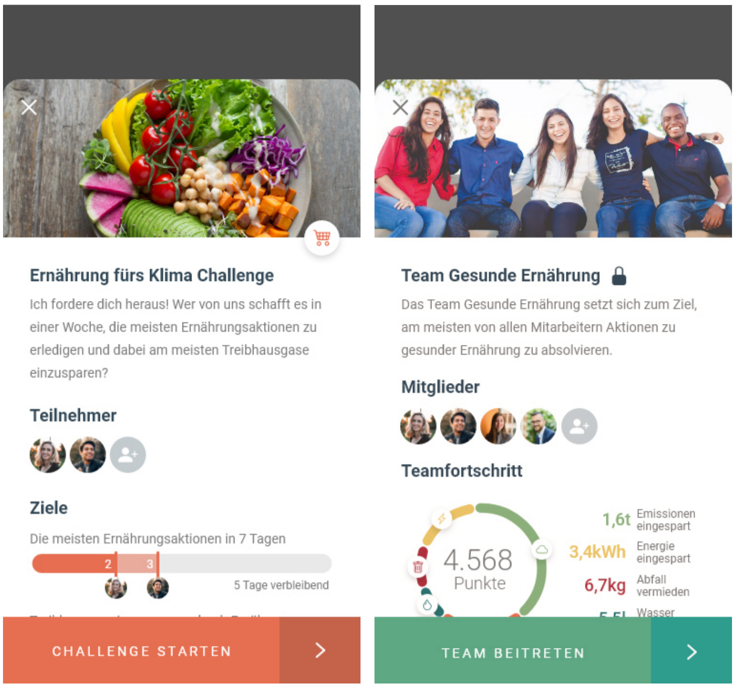


Figure 7.6: Mock-ups related to social comparison and collaboration (US12, US13).

side of Figure 7.7). In order to give users multiple ways to achieve their goals (US18), the application also provides detailed descriptions of the impact and relevance of different actions for sustainability (as shown on the right side of Figure 7.7). Besides suggestions to guide users towards their goals (right side of Figure 7.2), the application gives users the ability to browse all actions in all categories, read their detailed information, and thus decide for themselves which actions they want to pursue to achieve their goals (US18).

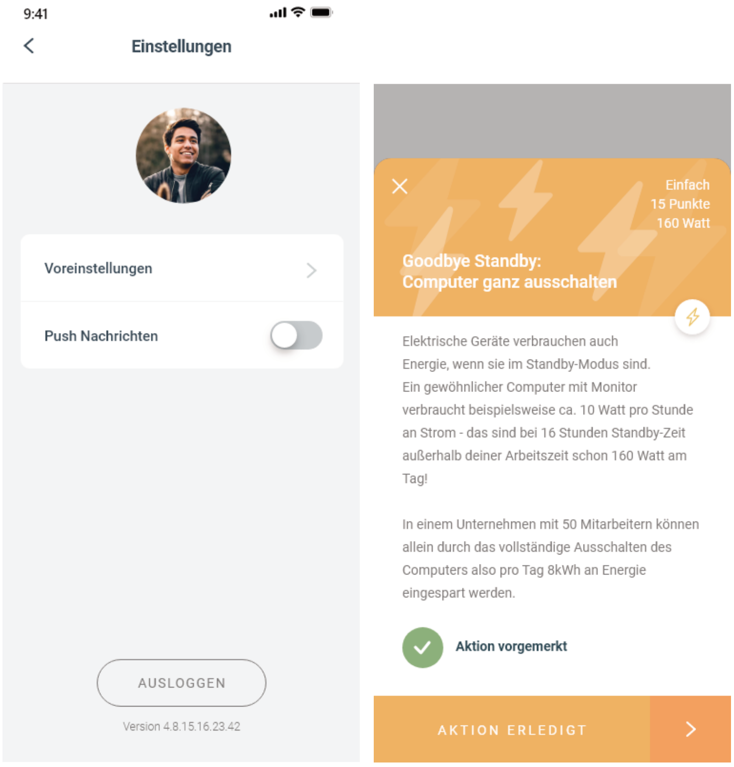


Figure 7.7: Mock-ups related to personalization and multiple paths (US15, US18).

In summary, the design and development of the click dummy carefully considers the user stories derived from the theoretical knowledge base. The latter consists of the theoretical principles derived from the review of the theoretical foundations of gamification, serious games, and game-based learning, and the design principles derived from the review of design principles in empirical research on gamification and persuasive systems. The following Chapter 8 presents the results of the evaluation of this developed artifact as the conclusion of the first DSR cycle of this research project.

# 8 Study 4: Qualitative Investigation of Design Features from Employees' Perspective




**Publication of this study.**

The content of this study has been published in adapted and shortened form in [96] J. Krath, B. Morschheuser, and H. F. O. von Korflesch, "Designing Gamification for Sustainable Employee Behavior: Insights on Employee Motivations, Design Features and Gamification Elements", in 55th Hawaii International Conference on System Sciences (HICSS), [Online], Jan. 2022, pp. 1594–1603, http://hdl.handle.net/10125/79530.


## 8.1 Context and Aim of this Study

Theoretically grounded design principles from both theory (Chapter 5) and previous research (Chapter 6) have guided the design of the first prototype of the gamified application for sustainable employee behavior at work in the first DSR cycle in the form of a non-functional click dummy. Following the FEDS framework, the developed artifact is now formatively evaluated to gain insights into design hypotheses and provide a basis for artifact improvement [103]. The goal is to understand the individual dispositions and expectations of employees, which must be taken into account in the further design of the gamified application based on this initial, artificial artifact.

The current study thus recognizes the relevance of including employees' perspectives in the design process at an early stage [123]. In previous research, employees' perspective on design features critical to the acceptance and continued use of gamified systems for sustainable behavior at work remains poorly understood. Current attempts to incorporate employees and their preferences into the design of gamification for sustainability have focused on quantitative evaluations of player types [538], motivational types [539], or dispositional parameters [540]. Yet, a profound understanding of employees' needs, motivations, and expectations, as well as the contextual characteristics of gamification in the workplace, is still lacking [541]. However, this has been highlighted as critical to the success of gamification [123], [542].

The present study aims to fill this gap. The aim of this study is to *include the perspective of the target group and to understand a) their motivations for sustainable behavior as well as b) their expectations for design features (e.g., utilitarian aspects and hedonic gamification elements) of such an app*. In this regard, it also intends to gather their impressions of the current artifact in order to identify concrete potential for improvement in the second DSR cycle.

[103]: Venable *et al.* (2016)

[538]: Kotsopoulos *et al.* (2018)
[539]: Kotsopoulos *et al.* (2018)
[540]: Kotsopoulos *et al.* (2017)
[541]: Warmelink *et al.* (2020)
[123]: Morschheuser *et al.* (2018)
[542]: Shahri *et al.* (2019)

## 8.2 Theoretical Background

In the course of the analysis, the VBN [160] serves as a guiding framework for classifying employees' motivations for sustainable behavior. As one of the most commonly used theories to explain sustainable behavior in general [156] and sustainable employee behavior in particular [151], [154], [155], it provides a valuable lens to explore the value foundations of employees that subsequently influence sustainable behavior through a norm-building process [161]. The VBN thus focuses on the effects of the social environment - such as a workplace - rather than an individual rational decision-making process, as does, for example, the TPB [135],

[160]: Stern *et al.* (1994)
[156]: Klöckner (2013)
[151]: Lülfs *et al.* (2014)
[154]: Sabbir *et al.* (2022)
[155]: Unsworth *et al.* (2013)
[161]: Stern *et al.* (1995)
[135]: Bamberg *et al.* (2007)

which is particularly useful to understand how contextual characteristics influence employees' motivations. The theory distinguishes between three categories of value orientation and according attitudes that shape intention to behave sustainably: *egoistic* value orientation and attitudes, which predispose people to protect the environment only when it affects them or those they care about, *humanistic* value orientation and attitudes, which lead people to care about the environment based on the costs or benefits to a human group or humanity as a whole, and *biospheric* value orientation and attitudes, that describe altruism directed toward the ecosystem beyond benefits to humans [160].

[160]: Stern *et al.* (1994)

This categorization supports the qualitative content analysis by providing a theoretically guided approach to classify different motivations for sustainable behavior. Furthermore, the general aspects of user experience in motivational IS [249] serve to cluster the results of the inductive qualitative content analysis of employees' expectations of design features for the gamified application.

[249]: Hamari *et al.* (2015)

As already explained in Chapter 3, Hamari and Koivisto [249] distinguish between three aspects of user experience in motivational IS, such as gamified systems, that influence attitudes toward a system and behavioral intentions to use the system: utilitarian aspects, hedonic aspects, and social aspects. *Utilitarian aspects* refer to the perceived usefulness of the system, i.e., the perception of the extent to which it enhances or supports the performance of a task [118], and perceived ease of use, which describes the perception of the effort required to use a system [118]. *Hedonic aspects*, on the other hand, refer to the experience of pleasure while using a technology [249]. In particular, gamified systems can evoke a playful experience because they suggest a new and creative way to approach a task [249]. Third, *social aspects* refer to the concepts of social influence [166] and relatedness [261]. On the one hand, social influence or social norms refers to the perception of how other users of the technology use it or expect oneself to use it [249]. On the other hand, relatedness refers to an inherent need for connection and social interaction with others [261], which includes aspects such as social recognition [249].

[118]: Davis (1989)

[166]: Ajzen (1991)

[261]: Ryan *et al.* (2017)

## 8.3 Research Method

Since the primary goal of this evaluation is to gain deep insights into employees' needs, motivations, and expectations, the study adopts an exploratory [543] and interpretive perspective, i.e., it seeks to understand the context of the gamified application and the reciprocal influences between the application, employees' expectations, and the workplace environment [544]. Accordingly, a qualitative research approach was chosen, which is particularly suitable for exploring people's perspectives and behaviors, as well as the context of a particular issue [545]. In this vein, semi-structured, exploratory interviews were chosen as the data collection method to identify employee expectations and motivations, as well as contextual factors, through in-depth interviews with employees of various companies striving to become more sustainable, in order to provide a basis for future design in the DSR cycle [546].

[543]: Makri *et al.* (2021)

[544]: Walsham (1993)

[545]: Kaplan *et al.* (2005)

The following research questions are aimed to be answered in this study:

[546]: Beck *et al.* (2013)

**RQ 1:** *What are employees' motivations for sustainable behavior at work?*

**RQ 2:** *What are employees' expectations for design features of a gamified application to support sustainable behavior at work?*

### 8.3.1 Data Collection

For data collection, semi-structured interviews as a suitable method for gathering in-depth information about individuals' personal and social affairs while at the same time allowing the researcher to focus on identified research questions [129] were used. Due to the Covid-19 pandemic and associated restrictions on in-person communication, the interviews were conducted remotely via Microsoft Teams. Prior to the data collection, each participant was informed about the details of the research procedure and their written informed consent was obtained.

[129]: DiCicco-Bloom *et al.* (2006)

At the beginning of each interview, the interviewer introduced the study context (workplace sustainability) and provided a brief explanation of gamification in relation to Deterding et al.'s definition, i.e., the *"use of game elements in non-game contexts"* [221]. Correspondingly, the interview followed a loose guideline, starting with the interviewee's daily work routines (What does a typical working day look like for you?), going over the topic of sustainability and motivations for sustainable behavior (Would you say it is important or unimportant that people behave sustainably in the workplace? For what reasons or motives would you act sustainably or change your behavior?), followed by an open discussion on the expectations for design features and game elements of a gamified app for sustainability in the workplace (How would a gamified app for sustainability need to be designed for you to use it? Which criteria would be particularly important to you? Which game elements would you find motivating?). Finally, the developed click dummy was presented to the respondents and they were asked about their perceptions and which features they particularly liked or missed. The pertinent interview guide was pretested with two participants to identify and eradicate any misleading questions or wording. Interviews were recorded using screen recording software and lasted between 34 and 78 minutes. Except for one interview, which was conducted in English and also transcribed in English, all interviews were conducted and transcribed in German.

[221]: Deterding *et al.* (2011)

### 8.3.2 Participants

27 employees working in four different companies in Germany were interviewed in February and March 2021. The companies operated in various industries and were selected to capture a wide range of different business activities. One focuses on industrial technology development (Company A), the second is in the web and media design industry (Company B), the third offers specialized software as a service (Company C), and the fourth deals with industrial glass production (Company D). The companies were contacted, and internal representatives recruited the interviewees. The representatives were asked to select participants to be as reflective of the

Table 8.1: Interview participants and their characteristics.

| No. | Gender | Age | Position | Job description | Company |
|---|---|---|---|---|---|
| P1 | Male | 29 | Follower | Marketing | Company A |
| P2 | Female | n.s. | Follower | Sustainability management | Company A |
| P3 | Male | n.s. | Manager | Process management | Company A |
| P4 | Male | n.s. | Follower | Product management | Company A |
| P5 | Female | 30 | Follower | Software development | Company A |
| P6 | Female | n.s. | Follower | Software development | Company A |
| P7 | Male | 43 | Follower | Sales | Company B |
| P8 | Male | 29 | Follower | Quality management | Company B |
| P9 | Male | 30 | Follower | Media design | Company B |
| P10 | Male | 24 | Follower | Software development | Company B |
| P11 | Male | 24 | Follower | Media design | Company B |
| P12 | Male | 39 | Manager | Executive board | Company B |
| P13 | Female | 32 | Follower | Marketing | Company B |
| P14 | Male | 23 | Follower | Media design | Company B |
| P15 | Female | 30 | Follower | Internal organization | Company B |
| P16 | Male | 28 | Follower | Software development | Company C |
| P17 | Female | 60 | Manager | Human resources | Company C |
| P18 | Female | 31 | Manager | Customer service | Company C |
| P19 | Male | n.s. | Manager | Executive board | Company C |
| P20 | Male | 38 | Manager | Customer service | Company C |
| P21 | Female | 33 | Follower | Staff position executive board | Company C |
| P22 | Female | 37 | Follower | Customer service | Company C |
| P23 | Female | 19 | Follower | Apprentice industrial clerk | Company D |
| P24 | Male | 41 | Manager | Research & development | Company D |
| P25 | Male | 35 | Manager | Procurement | Company D |
| P26 | Male | 42 | Manager | Marketing | Company D |
| P27 | Male | n.s. | Manager | Production | Company D |

company as possible. As a result, they ranged from service desk staff to software developers and product designers to team leaders and general managers, capturing the diversity of different employees for the study. Consequently, respondents formed a heterogeneous group in terms of gender, job description, position, and age (see Table 8.1).

### 8.3.3 Data Analysis

Following the approach of Mayring [547], a qualitative content analysis was conducted, as qualitative content analysis is not only the most popular text analytic method but also a suitable approach to extract findings relevant to the predefined research questions [548]. Accordingly, I opted for deductive coding concerning employees' motivations for sustainable behavior guided by Stern and Dietz's VBN theory [160] and inductive coding for design features for a gamified app and feedback regarding the prototype (data-driven approach [549]). All transcripts were uploaded to the MAXQDA data analysis tool. The inductive coding process involved (1) determining the level of selection and abstraction of categories to be coded, (2) linking text passages with the defined level of abstraction either to existing categories or forming a new category, (3) revisiting categories after 30% of the material, and (4) coding the remaining material without changing existing categories and adding new categories as needed [549]. For reliability testing, intracoder agreement checking as a measure of stability [549] was performed for 10% of the material, with an intracoder agreement rate of 94.44%.

[547]: Mayring (2015)

[548]: Mayring (2019)

[160]: Stern *et al.* (1994)

[549]: Mayring (2014)

After the coding process, the categories were clustered into groups to provide overarching insights towards understanding employees' expectations and desires. The classification was inspired by the general aspects of user experience in hedonic IS [249] to explore the role of these different aspects in the specific context of a gamified app for sustainable employee behavior in a structured way. In the following, excerpts from the interviews presented in the results are translated from German into English.

[249]: Hamari *et al.* (2015)

## 8.4 Results

### 8.4.1 Motivations for Sustainable Behavior

First, employee motivations for sustainable behavior were investigated to design appropriate narratives and pick up individuals with appropriate design features in the gamified app. In the interviews, a large group of employees expressed their concerns about the future of their own children and grandchildren in terms of resources such as fossil fuels, water, and food (P6, P8, P17, P19, P22, P27):

> *"Well, I actually think that this change has taken place in me because of my children, that you start to think about what kind of world do I want to leave to my children?" (P22).*

When investigating their statements, egoistic aspects were a common reason for sustainable behavior. In addition, several employees indicated that they care about the environment based solely on social norms, citing pressure from acquaintances (P12, P13) and the increasing social relevance of sustainable behavior:

> *"You get to hear it everywhere. I mean, how you should behave and what is sustainable for the environment and environmentally friendly. And of course, you try to behave accordingly. Simply because it feels righter" (P16)."*

Moreover, participants in management positions particularly emphasized that sustainable employee behavior maintains the company's competitiveness and should therefore be striven for (P19, P25).

The second, smaller group of workers emphasized the prospects for future human civilization and criticized the short-term view of current policies (P7), which is why they were classified as humanistically motivated. In particular, they pointed to the importance of today's sustainable behavior for future generations of all humanity (P4, P14), beyond their own children (P20).

Finally, the third group of employees indicated biospheric motivations as reasons for sustainable behavior. They explained their sustainable behavior by the observation that unsustainable behavior has led to *"islands of trash"* (P21) in the oceans, the death of animals from human waste on land and in water (P3), or the pollution of rivers (P15). Some of them also equated the state of the ecosystem with the health of the planet itself, which should be protected at all costs:

> *"Sustainability is, of course, a very, very crucial issue, because I think we have done enough damage to our planet for a long time without thinking about it. And we must and should start counteracting this now at the very latest" (P26)."*

## 8.4.2 Design Features and Gamification Elements

When asking for expected design features of a gamified app for sustainability, interviewees emphasized various factors that, according to the interviews, are of great importance for the acceptance and continued use of such an app at work. In particular, employees referred to utilitarian, hedonic, and social design features as well as the issue of data protection and consent, and provided valuable information about their impressions of the current prototype.

### Utilitarian Design Features and Elements

According to [249], design features were clustered as utilitarian if they enhanced the value of the app towards intended outcomes and supported ease of use, which refers to an efficient and obstacle-free user experience, as well as perceived usefulness, i.e., that the app enhances sustainable behavior. The analysis revealed seven clusters of utilitarian design features that were cited as important by the interviewees. These are easy access, intuitive user interface, onboarding, intelligent support, goal setting, performance tracking, and appropriate incentives (see Table 8.2).

[249]: Hamari *et al.* (2015)

**Easy access.** In terms of easy access, employees mentioned that a gamified app for sustainability should be accessible through their smartphone for them to use, especially since it should not distract from main work tasks and would be primarily used during breaks or at the end of the workday. In addition, some employees desired a complementary browser app that should not replace a smartphone app but increase its informational value. For example, it should provide advanced statistics on employees' sustainable behaviors, mentioned in particular by participants that lead the research project within the company (P2, P17), and overall sustainability performance. Particularly noteworthy is the suggestion of two employees who proposed facilitating the use of the gamified app by linking it to internal communication systems, such as MS Teams (P26).

**Intuitive user interface.** In addition, the employees emphasized the importance of an intuitive user interface that simplifies the use of the gamified app. A vital aspect of the user interface should be a pragmatic structure that *"(...) must not be cumbersome to use, because otherwise it quickly degenerates into work again"* (P16) and has an *"intuitive structure, (that) can be learned quickly"* (P21), i.e., the gamified app should not be overburdened with too many elements, tabs, and navigation. Instead, since the gamified app aims at sustainability in the work environment, it was important for employees to be able to use the app with as little time as possible and to have quick access to the main actions in the app. For

Table 8.2: Utilitarian design features and elements.

| General aspect | Cluster | Expected design features | Participants that cited the feature |
|---|---|---|---|
| Ease of use | Easy access | Smartphone app | P2, P3, P4, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P20, P21, P22, P24, P26, P27 |
| | | Browser app | P2, P10, P16, P17, P20, P22, P24, P26 |
| | | Integration with existing systems | P24, P26 |
| | Intuitive user interface | Pragmatic structure | P2, P4, P5, P11, P14, P15, P16, P20, P21, P22, P25, P26, P27 |
| | | Quick access to main actions | P15, P16, P19, P22, P24, P25 |
| | Onboarding | Explanatory introduction | P7, P14, P15, P21, P22, P26 |
| | | Access during use | P26 |
| Usefulness | Goal setting | Customizable goals | P2, P4, P8, P18, P21, P22, P23 |
| | | Daily goals | P4, P18, P20 |
| | | Clear and achievable goals | P20 |
| | Intelligent support | Path to the goal | P7, P8, P11, P12, P20 |
| | | Personalized recommendations | P5, P9, P10, P12, P20, P23, P25, P26 |
| | | Reminders | P1, P12, P18, P19, P20, P22, P25, P26 |
| | | Automatic tracking | P6, P24 |
| | Performance tracking | Transparent impact metrics | P1, P2, P3, P4, P6, P7, P8, P10, P12, P13, P14, P17, P20, P22, P25, P26 |
| | | Explanation of abstract units | P4, P6, P17, P20, P24 |
| | | Trend indicators | P4, P25 |
| | Appropriate incentives | Tangible rewards | P3, P9, P10, P12, P19, P21, P27 |
| | | Donations | P1, P5 |

example, they mentioned the introduction of checklists that allow quick input of sustainability actions performed during the day (P15, P16, P22). Such a design would enable employees not to have to actively search for how to enter their sustainability actions into the app but to remain in a time-efficient, reactive position where they can simply check off when they have completed an action (P19).

**Onboarding.** Furthermore, respondents cited the importance of onboarding in the form of a tutorial (P15), a go-through (P26), or a visual introduction (P21) as a relevant aspect for increasing usability. The onboarding should explain the most important functionalities of the gamified app to ease the entry, especially since the topic of sustainable behavior is not necessarily self-explanatory:

> *"The app must tell you 'Here, here I am, I can do that. Here you can do this, here you can do that.'" (P14).*

One employee also mentioned that it would help usability if this introduction were accessible in the app to view again after some inactivity (P26).

**Goal setting.** Concerning the support of sustainable behavior, many employees mentioned that the gamified app should allow them to set their own goals. Employees would like to choose which dimension of sustainable behavior, e.g., saving energy, reducing waste, or biking to work, they would like to work on (P2, P21), and they want to be able to change their focus from one week to another (P22). In addition, interviewees mentioned the assistive function of daily goals that should be provided (P4, P18, P20) to give them an idea of what they could work on that day. One employee emphasized that the goals set should be clear, measurable, and achievable, i.e., SMART, to be motivating (P20).

**Intelligent support.** Beyond goal-setting functionalities, employees expect the gamified app to provide intelligent support in pursuing their goals. Some respondents described that the gamified app should provide a clear path to the goal, i.e., tell them what they need to do to achieve their goals, e.g., by offering an overview of possible actions for sustainability (P11, P12). Several interviewees also mentioned personalized recommendations adapted to their current sustainable behavior and goals as an essential supporting element. For example, the gamified app should display sustainability actions based on active challenges (P9) and suggest further goals based on current objectives (P10). In addition, employees liked the app to consider situational factors for personalized suggestions, such as whether it is quitting time and one should turn off the computer (P20) or whether the employee is in a specific location (P12, P25). Similarly, employees emphasized the integration of reminders that actively encourage them to engage in sustainable behaviors, for example, in the form of push notifications (P1, P6, P19, P20). Especially in the work context, the focus is not inherently on sustainable behavior, so reminders should be used to remind people to take quick and small actions toward sustainability, such as turning off the lights (P22, P25). Furthermore, some respondents advocated for automatic tracking of sustainability actions. Specific suggestions include connected sensors, such as smart light switches that measure whether the office light is on (P24), and Bluetooth gadgets on trash cans that track whether the employee has disposed of paper (P6).

**Performance tracking.** Several interviewees expressed that a gamified app for sustainability in the workplace should help visualize and understand personal sustainability performance and progress, e.g., by displaying various sustainability-related metrics (P3, P4, P10, P13, P26). Relatedly, employees also desired immediate feedback on how specific actions improved their performance (P3, P8), e.g., having the gamified app show a message that they saved 160 watt-hours of energy by turning off the lights, as well as an overview of their past activities and how they related to performance metrics (P4, P6, P8). Also, participants pointed out that sustainability metrics, such as kilowatt-hours of energy, need to be made understandable through tangible examples:

> *"So many kilometers not driven or something, one load of the washing machine not washed, for energy saved (...) Because only numbers are difficult to capture" (P6).*

Moreover, some employees referred to the display of trend indicators that illustrate the direction of future performance (P4, P25).

Table 8.3: Hedonic design features and elements.

| General aspect | Cluster | Expected design features | Participants that cited the feature |
|---|---|---|---|
| Enjoyment | Appealing visual design | Suitable colors | P9, P14, P15, P20, P23 |
| | | Juicy feedback | P3, P8, P14 |
| | | Brand customization | P2, P8, P26 |
| | Continuous excitement | Variable content | P1, P14, P20, P25, P26 |
| | | Difficulty adaption | P4, P25 |
| | Emotional reinforcement | Motivational messages | P1, P8, P9, P18 |
| Playfulness | Ludic goals | Virtual achievements | P3, P4, P7, P9, P13, P15, P20, P25, P26 |
| | | Points and level systems | P3, P4, P9, P12, P14, P19, P20, P21, P26 |
| | Playful learning | QuizzesP3, P6, P7 | |
| | | Informational hints and nudges | P1, P2, P4, P10, P13, P17, P18, P22, P25, P26 |
| | Exploration | Unlockable content | P4, P9, P21 |
| | | Easter eggs | P2, P6 |

**Appropriate incentives.** Finally, some employees requested tangible incentives for achievements in the gamified app, or redeemable points, as a prerequisite for being motivated to engage in sustainable behaviors through the app. Several employees seeking such rewards emphasized the importance of appropriateness in the context of sustainability, suggesting, for example, coupons for sustainable stores (P10), sustainable cooking recipes (P3), team parties (P12), or a parking lot for the *"sustainable employee of the week"* (P27). In addition, the employer could reward individual and team achievements with a donation to social and pro-environmental projects in their name (P1, P5).

## Hedonic Design Features and Elements

Hedonic design features serve to promote positive user experiences, such as enjoyment when using the app, and to frame desired behaviors as playful activities to increase fun [249]. In the interviews, six thematic clusters of hedonic design features desired by the employees were identified: appealing visual design, continuous excitement, emotional reinforcement, ludic goals, playful learning, and exploration (see Table 8.3).

[249]: Hamari *et al.* (2015)

**Appealing visual design.** In terms of the aesthetic design of the user interface, employees emphasized the use of sustainability-related signal colors and images in the gamified app. Colors such as green, blue, or yellow were associated with sustainability and considered appropriate for a coherent design concept (P15, P20, P23). In addition, some employees indicated that they would like to receive juicy and visually appealing feedback when using the app:

> *"I would be delighted if, for example, I confirm 'I just flushed the toilet for a third' and someone is jumping across the screen, yes, literally, with a toilet brush, or something like that, and he's making funny faces" (P3).*

Moreover, some participants expressed the importance of aligning the appearance of the gamified app with the corporate identity, e.g., by using the company logo (P2, P26) or colors (P8), suggesting that customization is vital to foster employee relatedness.

**Continuous excitement.** To maintain enjoyment, respondents referred to the need to keep the gamified app exciting by continuously introducing new content, suggesting that employees fear a bit of a boredom effect after a certain period. New content could include new sustainability topics (P25) or promotional periods for specific themes (P1, P14, P20). The gamified app could also adapt the content to the season, e.g., suggest regular airing in summer and heating-related sustainability actions in winter (P25). Another possible design feature to promote long-term engagement mentioned by employees is dynamically adjusting the difficulty level depending on the players' experience, e.g., matching the points required for success to the user's experience (P4) and proposing new actions upon success with the pre-existing ones (P25).

**Emotional reinforcement.** As a third aspect related to enjoyment, the participants emphasized the inspiring effect of motivational messages to strengthen self-efficacy and further promote motivation. The gamified app should inform about the current successes and motivate to persist:

> *"Again and again a 'yeah, you did super cool! Come on, keep going. If you do this next challenge now, then you'll be even more sustainable!' and so on." (P9).*

**Ludic goals.** In relation to the utilitarian features of goal setting, participants noted that the gamified app would be a great way to use multiple gamification elements that playfully frame the goals as part of a game, e.g., by introducing virtual badges for goal achievement, such as a badge for separating trash ten times (P9). Points and level systems should also be considered as gamification elements that allow the playful setting of personal goals related to overall sustainability performance (P4) and illustrate personal development (P20, P21).

**Playful learning.** Moreover, employees mentioned quiz games (P3, P6, P7) as gamification elements to learn about sustainability entertainingly and to compare their knowledge with others. In this context, a tip of the day (P13) or informative hints during the day (P26) could serve as a playful way to expand knowledge in small *"appetizers"* (P1) about how to improve one's own sustainability performance and why individual behavior is important (P4, P10) without employees having to actively and time-consumingly study these topics.

**Exploration.** As a final group of hedonic design features that promote positive experiences while using the gamified app, participants pointed to the possibility of exploration. Specific suggestions included introducing unlockable content (P4), such as avatar add-ons (P9, P21), and hiding Easter eggs that can be discovered when a specific combination of sustainable achievements is reached (P2, P6).

Table 8.4: Social design features and elements.

| General aspect | Cluster | Expected design features | Participants that cited the feature |
|---|---|---|---|
| Social influence | Performance comparisons | Peer statistics | P6, P7, P10, P13, P14, P16, P25 |
| | | Leaderboards and rankings | P1, P3, P4, P5, P6, P10, P12, P19, P20 |
| | | Challenges | P1, P2, P5, P12, P14, P18, P21, P26 |
| | Reciprocal support | Team organization | P1, P2, P5, P6, P7, P8, P15, P16, P18, P20 |
| | | Ideation features | P4, P5, P6, P17, P21, P24, P27 |
| | | Idea voting | P3, P8 |
| | | Messaging features | P4, P23 |
| | Fairness | Fraud detection | P1, P8, P12, P15, P27 |
| Recognition | Social praise | Social media sharing | P1, P26 |
| | | Likes and comments | P8, P12, P26 |
| | Customizable presentation | Profiles and avatars | P8, P20 |

### Social Design Features and Elements

Finally, social design features refer to features that enable social influence, i.e., mutual influence among employees in using the app and performing sustainable behaviors, and that allow for social feedback and recognition [249]. In this context, employees mentioned design features in five thematic clusters: performance comparisons, reciprocal support, fairness, social praise, and customizable presentation (see Table 8.4):

[249]: Hamari *et al.* (2015)

**Performance comparisons.** First, respondents indicated that they would like the gamified app to display not only their own sustainability metrics but also those of their colleagues to enable peer comparison. In particular, upward comparisons could foster personal motivation to beat colleagues and behave more sustainably (P10, P13, P14). Employees would also like to see leaderboards and internal rankings that encourage them to achieve first place (P10) or at least a place in the top ten (P20). In this context, some participants emphasized rankings with different categories or periods, so that there is not just a one-time top performer, but each participant has the chance to become *"weekly leader"* (P4) or *"top challenger in a particular category, so to say, (...) 'veggie of the month is Klaus from the IT department'"* (P26), indicating their need for equal chances of success to stay motivated. In addition, employees from companies with multiple sites (P1, P19) added rankings between companies as an encouraging feature. Moreover, competitive elements such as challenges, e.g., to go vegetarian for a week (P18), were highlighted as another gamification element to encourage sustainable behavior. One employee added the possibility to *"annoy"* colleagues in a playful way to promote the idea of competition:

> *"So hindering others in achieving their goals (...) you could have something like a kind of wild card and the other person then has to scratch the whole screen free before moving on to the next level"* (P14).

**Reciprocal support.** In addition to competitions, employees also mentioned collaborative gamification elements and design features to help them stay motivated. Several participants felt that organizing into teams was particularly important for achieving sustainability goals together (P16, P20), allowing for competition between teams while promoting cohesion within teams (P1, P2, P5, P6, P7). In addition, employees cited the potential to use the gamified app as a tool for collaboration and sharing, for example, by introducing idea features that facilitate suggesting sustainability actions that might be of interest to others. Voting on proposed ideas and goals was mentioned as an additional gamification element to make idea sharing among colleagues more fun (P3, P8). Messaging features were highlighted to ease exchange among team members (P4, P23).

**Fairness.** Apart from these positive aspects of introducing competitive and collaborative design features, several employees were concerned that other colleagues might cheat in the gamified app (P1, P8, P12, P15, P27) and stressed the introduction of some kind of fraud detection or social control mechanism to discourage cheating (P8). This indicates that fairness is an important aspect, especially in the workplace, for employees to adopt competitive gamification elements as motivational inducements for sustainable behavior.

**Social praise.** In terms of social recognition for successful sustainable behavior, some participants mentioned being able to like the actions of others (P8, P12) and openly praising colleagues for their contribution to shared goals (P26) as ideas for valuing individual performance. In addition, sharing accomplishments on social media could publicize employees' sustainability successes outside the company (P1, P26).

**Customizable presentation.** Finally, two employees mentioned the ability to present oneself in profiles and avatars, especially with photos (P8) and an area to showcase one's accomplishments (P20), as motivating social design features.

### Data Protection and Consent

Beyond design features that relate to the general aspects of user experience in hedonic IS [249], another noteworthy aspect was considered an important design feature of a gamified app in a work context, namely the issue of data protection and consent. Specifically, concerned employees requested consent forms for data processing within the app (P17, P22), admin roles for limited access to administrative overviews (P26), and protection from external access so that personal employee data is only displayed within the organization (P17). Although privacy may often be an uncomfortable and time-consuming topic for gamification designers, the results highlight its importance for gamified apps, especially in work-related contexts where employees entrust sensitive personal data to the company and thus to the app designer.

[249]: Hamari *et al.* (2015)

### Impressions of the Current Prototype

In addition to discussing the expected design features at a general level, participants were shown the developed click dummy of the gamified app for

Table 8.5: Positive impressions of the current prototype.

| General aspect | Cluster | Positive impressions | Participants that noted the impression |
|---|---|---|---|
| Ease of use | Intuitive user interface | Clear design | P1, P2, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P15, P16, P18, P19, P22, P23, P24, P25, P26, P27 |
| | | Quick and easy navigation | P10, P11, P16, P18, P27 |
| | | Favorizing actions for fast access | P1, P6, P12, P13 |
| Usefulness | Informational content | Action information that explains the effect of the action | P5, P13 |
| | | Ability to browse all actions | P10 |
| | Goal setting | Goal suggestions to choose from | P10, P13, P14, P16, P19, P23, P26 |
| | | Ability to browse all goals | P7 |
| | Intelligent support | Categorization of actions | P12 |
| | Performance tracking | Dashboard with key metrics | P1, P2, P7, P9, P10, P11, P14, P15, P16, P17, P18, P20, P22, P23, P26, P27 |
| | | Personal sustainability statistics | P6, P10, P11, P12, P14, P15, P19 |
| Enjoyment | Appealing visual design | Symbols and colors that illustrate categories | P13, P14, P15, P19, P20, P22, P23, P26 |
| | | Pictures for goal illustration | P3, P13, P16, P20, P22, P26 |
| | | Use of overlays for actions and goals | P11, P15, P20 |
| | | Direct feedback animations | P14 |
| Playfulness | Ludic goals | Virtual achievements with variable difficulty | P6, P12, P13, P15, P19 |
| | | Levels and level progress | P14, P20 |
| Social influence | Performance comparisons | Ranking list only displays the top 10 | P20 |
| | | Explore other user profiles | P11, P13 |
| Recognition | Customizable presentation | Ability to present achievements to others | P11 |

sustainable employee behavior at work to gather their current impressions of the artifact. Overall, participants mentioned several positive impressions related to all aspects of the user experience [249], but also valuable areas for improvement, mainly related to utilitarian aspects and visual design.

[249]: Hamari *et al.* (2015)

**Positive impressions.** Participants expressed several positive impressions about the utilitarian aspects of the user experience (shown in Table 8.5). In terms of ease of use, the majority of respondents highlighted a clean design and quick and easy navigation, which contributed to intuitive use of the application. They also underlined the feature of favorite actions as a good approach for quick access to the most important actions of the application (P1, P6, P12, P13). In addition, participants noted a variety of positive impressions regarding the usefulness of the gamified application to help them engage in sustainable behaviors in the workplace. In particular, some employees emphasized the usefulness of the informational content provided about sustainability actions (P5, P13) and the ability to choose from predefined suggestions for goal setting (P10, P13, P14, P16, P19, P23, P26).

> *"The search line is also very, very good, so that I can just look, "Vegetarian lunch" or I would now like to eat vegan for a week, let's say, then I can enter like vegan lunch or so I find the corresponding challenge.(...) I think that's great" (P10).*

Furthermore, participants liked the categorization of measures into different sustainability dimensions (P12) and the ability to track their performance on the dashboard with key sustainability metrics (P1, P2, P7, P9, P10, P11, P14, P15, P16, P17, P18, P20, P22, P23, P26, P27).

> *"Ah, that's cool. I can see how many tons I guess of CO2, how many emissions we've saved, I click right on it. Okay, that's good too. There are several (..) several factors. Or indicators that you can look at. Water, energy, CO2 and waste, it's about avoiding waste, that's also cool, I like the different colors" (P20).*

In terms of hedonic aspects, participants highlighted in particular that the illustration of categories with icons and colors, the use of images, the use of overlays for actions and goals and direct feedback animations contribute to an appealing visual design of the app. In terms of the playful aspect, they pointed out that the app offers virtual achievements (P6, P12, P13, P15, P19) and levels (P14, P20) as features to ludify goals.

> *"I find this area very, very beautiful, in fact. Because there is also a further differentiation with the badges, which are increased again. So you can see not only do I already have 3 badges in the area, but they are also staggered again so that you can see that one is better than the other" (P13).*

Finally, participants referred to some social aspects of the user experience that were satisfied by the current design of the application. In particular, they highlighted that the leaderboard displays only the top 10 users to avoid downward comparisons (P20) and that the app offers the possibility to explore other users' profiles (P11, P13), which favorably contributes to performance comparisons. In addition, the ability to showcase achievements to others represented a suitable approach for customizable presentation and gaining social recognition (P11).

**Possibilities for improvement.** In general, participants mentioned more possibilities for improvement than positive impressions of the current prototype, mainly related to ease of use, usefulness, and visual design challenges (shown in Table 8.6 and Table 8.7). In terms of utilitarian aspects, participants saw several opportunities to improve usability through better user interface design, such as reducing the effort required to select and execute actions and streamlining various aspects of navigation.

> *"So it's a lot of clicks to perform an action. And (...) if I do that several times a day. Yes, so then the next time the hurdle is perhaps minimally larger to do that. Well, it's not really annoying or anything. But I would wish that one or two clicks less are necessary" (P16).*

Table 8.6: Possibilities for improvement of the current prototype (utilitarian).

| General aspect | Cluster | Possibilities for improvement | Participants that noted the possibility |
|---|---|---|---|
| Ease of use | Easy access | Add English language | P1 |
| | Intuitive user interface | Reduce effort to complete actions | P4, P6, P9, P11, P15, P16, P17, P21, P22, P25 |
| | | Display actions on start page | P1, P9, P11, P20, P25 |
| | | Add opportunity to filter and sort actions | P4, P11 |
| | | Ease favorizing actions | P9 |
| | | Link profile with level status on start page | P7, P8, P10, P14, P19, P20, P21 |
| | | Move settings from burger menu to profile | P1, P4, P8, P19 |
| | | Omit navigation in two directions (vertically and horizontally) | P15 |
| | | Improve visibility of navigation | P9, P11, P19, P20 |
| | | Reduce subnavigations | P25 |
| | | Omit nested overlays | P8 |
| | | Increase button size | P14 |
| | | Add back button | P10, P16 |
| | | Add possibility to undo actions | P1 |
| | | Explain function of plus button in navigation | P21, P22, P25 |
| Usefulness | Goal setting | Illustrate difference between current and suggested goals more clearly | P1 |
| | | Add opportunity to sort and filter goal suggestions | P2, P11 |
| | Intelligent support | Improve link between goals and actions | P3, P5, P6, P7, P8, P19, P20, P24 |
| | | Explain distinction between goals and actions | P1, P8, P9, P10, P11, P12, P13, P14, P15, P16, P20, P22, P26 |
| | | Improve explanation of categories | P2, P4, P6, P17, P20, P24 |
| | | Remove nutrition as a category | P4 |
| | Performance tracking | Improve link between dashboard and company | P2, P4, P5, P6, P7, P10 |
| | | Present current status of a goal more clearly | P2, P9, P11, P21, P26 |
| | | Add possibility to customize dashboard | P1, P11, P16 |
| | | Display timeframe of metrics on dashboard | P4, P5 |
| | | Add possibility to switch between company metrics and own metrics on dashboard | P11 |
| | | Explain abstract metrics | P2, P4, P6, P17, P20, P24 |

One respondent also pointed out that English language was a necessary requirement for the application to be accessible to all employees (P1). In addition, respondents cited several ambiguities in the design of goals and actions that negatively impacted the experience of usefulness. For example, employees desired a better distinction between goals and actions, and at the same time, a better explanation of how they are linked so that support for achieving goals works as intended.

*"Okay, I have a challenge going on here. It's about nutrition. And then I would also like to see with which actions I can contribute to this challenge. That's what I would like to see now" (P20).*

Table 8.7: Possibilities for improvement of the current prototype (hedonic and social).

| General aspect | Cluster | Possibilities for improvement | Participants that noted the possibility |
|---|---|---|---|
| Enjoyment | Appealing visual design | Design goal overview more exciting | P1 |
| | | Redesign action buttons to display less symbols | P15, P25 |
| | | Modernize design | P7, P15, P25 |
| | | Use more fresh colors | P11, P12 |
| | | Omit shadows | P9 |
| | | Select other icons for categories and navigation points | P1, P2, P4, P6, P7, P8, P9, P14, P15, P16, P17, P19, P20, P21, P22, P25, P27 |
| | | Select category colors that do not suggest performance | P7, P8, P20 |
| Playfulness | Ludic goals | Add titles or designations for levels | P26 |
| | | Explain level system | P4, P5, P6, P15, P19, P25 |
| | | Improve illustration of achievements and progress | P5, P6, P9, P10, P11, P14, P17 |
| | | Improve depiction of points earned by an action | P2 |
| | Exploration | Add Easter eggs | P20 |
| Social influence | Performance comparisons | Add possibility to compare key metrics with others | P1 |
| | | Display more information on other users | P16 |

Participants also suggested improving the transparency of performance tracking, for example, by more clearly displaying the current status of a goal (P2, P9, P11, P21, P26), showing the timeframe of the metrics on the dashboard (P4, P5), clearly indicating to whom the metrics relate (to the company or to oneself) (P2, P4, P5, P6, P7, P10), making it possible to switch between own and company metrics (P11), and better explaining the abstract metrics (P2, P4, P6, P17, P20, P24).

Regarding the hedonic aspects of the user experience in the current prototype, despite the positive aspect of using color coding and symbols for categories, participants were still dissatisfied with the visual design of the click dummy and suggested modernizing the design (P7, P15, P25), using fresher colors (P11, P12) and omitting shadows (P9), changing the colors of the categories (P7, P8, P20), and changing the symbols currently used.

> *"The tiles up here especially and the color of the font, the tile shape and the background remind a bit of early WordPress times" (P15).*

Regarding the playfulness aspects, participants wished for more explanations of the point and level system (P4, P5, P6, P15, P19, P25) and the progression of achievements (P5, P6, P9, P10, P11, P14, P17), and suggested adding titles or labels for the levels (P26). Notably, the current prototype did not include features for playful exploration, but one participant specifically suggested adding this aspect in the form of Easter eggs (P20).

Finally, two respondents added that a way to compare key metrics with other users (P1) and generally display more information about others (P16) could improve performance comparisons as part of the social aspects of the user experience.

## 8.5 Discussion

This study revealed novel insights into the design of effective gamified apps for engaging sustainability behavior at work. Besides this core contribution, the findings shed new light on the overall discussion of user involvement in the gamification design process [1], [123], [550]. In terms of reasons for sustainable behavior, employees' motivations can be divided into three categories, similar to the distinction made by VBN theory [160]. First (I), the largest group of the interviewed employees noted egoistic reasons, such as motivation to contribute to a better future for their children and grandchildren. In addition, another group of interviewees (II) mainly emphasized social pressure as a core motivation for sustainable behavior, and a third (III) category of interviewees have already thoroughly engaged with the impact of today's behavior on future human generations (humanistic motivations) and ecosystem health (biospheric motivations).

[1]: Krath *et al.* (2021)
[123]: Morschheuser *et al.* (2018)
[550]: Norman (2005)

[160]: Stern *et al.* (1994)

To address these different target groups, gamification designers could draw on various design features highlighted in the interviews (Table 8.2, Table 8.3, Table 8.4, Table 8.6, Table 8.7). Employees mainly referred to utilitarian design features that support easy access, intuitive use, and personal development, e.g., goal setting, intelligent support, and performance tracking. In this context, the impressions of the current prototype have made it clear that a transparent explanation of the supporting functions and performance tracking is crucial for them to be effective. Hedonic design features were primarily cited for reinforcing this individualistic progression by ludifying goals, enabling playful learning, and supporting continuous excitement. In addition, impressions of the current prototype showed that while an appealing visual design was not a particularly important feature expected by employees, it does have a large impact on the hedonic experience and, if not properly implemented, greatly reduces positive impressions of the application. In contrast, social design features were expected mainly to enable social comparisons and team organization for inter-team competition.

When encouraging employees to behave more sustainably, designers should use engaging narratives and missions, such as *"Save the future of your children"* to address individualistic concerns of more egoistically motivated employees (I). Further, they should consider illustrating the impact of personal contribution in performance metrics and reinforce self-efficacy through immediate and appealing feedback as these features are known to engage sustainable behavior on an individual level [28]. Group II might be engaged with more social design features that exert social influence (Table 8.4). Group III is unlikely to need social pressure or persuasive narratives because they have already engaged with how their behavior contributes to sustainability. Instead, gamification designers should prioritize informational design features that support these employees in how to act (even more) sustainably by offering personalized recommendations, informational cues, and idea exchange features.

[28]: Khosrowpour *et al.* (2018)

## 8.6 Implications

The findings contribute to the existing literature and practical design of gamification in various dimensions.

### 8.6.1 Implications for Theory

The results contribute to the ongoing discourse on the primary motivations for sustainable behavior by observing that several employees cite egoistic motivations, i.e., the future of their own children and social pressures, and are thus not inherently motivated to do what they can to improve sustainability in the workplace. This result is exciting in light of previous studies in which humanistic and biospheric motivations were more prominent than egoistic ones [551], [552]. The findings may be explained by noting that they have examined target groups that are likely already aware of the relevance of sustainable behaviors and the impact of their own actions (e.g., climate change mitigation [551] or students [552]). This study can serve as an anchoring point for further studies and highlights the need to investigate the motivations of the target group, as these motivations influence which design features (e.g., persuasive elements that convey relevance versus informative elements that support behavior maintenance) should be prioritized in specific contexts.

[551]: Howell *et al.* (2017)
[552]: Tolppanen *et al.* (2021)

Although user involvement in the gamification design process is widely regarded as a critical design principle for successful gamification [1], this study revealed potential limitations of this approach. Our results show that employee expectations and previous research findings differ, suggesting that consideration of user feedback should be done with caution and related to quantitative research findings. For example, it is surprising that employees mentioned various design features and gamification elements primarily associated with individual effort, self-development, and competition, despite previous research indicating that sustainable behavior requires collective engagement rather than individualism [365]. Similarly, concerning rewards, studies in the work context have shown that extrinsic rewards usually have only short-term effects [553]. However, respondents cited appropriate rewards as an essential design feature. One possible explanation for this could be that the design features expected by users in advance differ from what they find motivating when using gamified apps. In addition, a variety of possible game elements known from research, such as storytelling, virtual assistants, or simulations [48], which might be particularly suitable to appeal to those employees who have yet to become aware of the impact of their own actions, were not mentioned at all by participants, possibly due to limited knowledge. These observations suggest that although user involvement in the design process is crucial [1], user perceptions should be interpreted with caution when designing gamification and supported by findings from previous studies and real-world experiments.

[1]: Krath *et al.* (2021)
[365]: Lozano (2007)
[553]: Morschheuser *et al.* (2017)
[48]: Koivisto *et al.* (2019)

### 8.6.2 Implications for Practice

The results of this study yielded various insights that may be relevant to the future design of gamified apps for workplace sustainability. For example, designers should explore how gamification can be seamlessly and effectively integrated into daily work processes, with as little interference as possible from main work tasks. Embedding gamification and sustainability goals into existing solutions and processes could therefore be beneficial compared to more monolithic gamification approaches, and comprehensive user interface testing is essential to ensure a smooth and seamless user experience.

In addition, designers should prioritize design features, both utilitarian (e.g., performance metrics, recommendations, and reminders), hedonic (e.g., virtual achievements, point, and level systems, and informational hints), and social (e.g., intra-, and inter-team challenges and leaderboards), that support individual goal setting and tracking. Previous research has shown that goal setting is one of the most effective mechanisms for sustainable behavior change [554]. Besides leaderboards, which can successfully support goal setting in a work context [420], the findings suggest that other elements such as achievements, reminders, levels, or challenges could also be helpful for goal setting, which provides a starting point to explore the implications of these elements for gamification design for workplace sustainability.

[554]: Osbaldiston *et al.* (2012)

[420]: Landers *et al.* (2017)

Finally, the results highlight the role of aesthetic design in enabling enjoyable experiences with gamified applications. While some studies have emphasized the importance of the aesthetic experience as being as important as the functionalities of the system [555], most design frameworks for gamified systems stress the functionalities rather than the visual design of gamification [250]. The findings suggest that gamification designers, in their attempt to select and develop the most appropriate functionality for their application, should not forget the visual design decisions for the user interface such as navigation, colors, icons, symbols, and images to sustain the enjoyment of using the application.

[555]: Suh *et al.* (2017)

[250]: Mora *et al.* (2017)

## 8.7 Conclusion and Limitations

While gamification has been shown to influence employee behavior effectively, current attempts to design gamification for sustainability in the workplace largely neglect the importance of understanding personal factors and contextual characteristics. Therefore, this first DSR evaluation explores employees' motivations for sustainable behavior and expectations for design features. The results show that many employees tend to be egoistically motivated, suggesting the design of appropriate narratives and individualistic-oriented design features. Employees expected utilitarian, hedonistic, and social design features that primarily serve to support them in achieving personal sustainability goals while highlighting that gamification at work should also integrate seamlessly with existing work routines. However, this study is not without limitations that open further avenues for further research in the context of gamification for sustainable employee behavior.

First, I exploratively investigated employee motivations for sustainable behavior and expectations for design features of a gamified app at work. While the in-depth interviews allowed to explore employees' perspectives in-depth and identify clusters of important design features in the context of workplace sustainability, future empirical studies should assess the generalizability of the findings using quantitative research designs. In particular, studies should further investigate the distribution of different motivations for sustainable behavior and the relative importance of the design features identified, both from an employee perspective and in terms of their influence on behavioral outcomes.

Second, the study revealed inconsistencies between employee perceptions and theoretical propositions about gamification design. However, it was not able to draw a conclusion about which design hypothesis is more effective. Further research that draws on this observation and opts for comparative empirical research could give more evidence and add to the ongoing discourse [550] of benefits and limitations of user involvement in design processes.

[550]: Norman (2005)

Finally, the sample was limited to mainly male employees from four different companies in Germany and thus focused on a specific work environment, mainly in the industrial and IT services sector, with a certain cultural background. Further research encompassing employees from larger companies, other industries, and with different geographic and cultural backgrounds might be conducted to investigate how these contexts influence the successful design of gamification for sustainable employee behavior.

The preceding qualitative evaluation of the first prototype of the gamified app led to the following key insights for the further development in the second DSR cycle:

- Employees are primarily egoistically motivated to contribute to sustainability at work, and therefore need to be addressed by design features that help them set goals and manage their behavior with minimal effort
- Employees cited utilitarian, hedonic and social design features (Table 8.2, Table 8.3 and Table 8.4) which provide valuable input on which features should be included in the MVP design of the gamified app
- Employees provided valuable suggestions for improving the current prototype (Table 8.6 and Table 8.7) that will specifically help increase the usefulness, ease of use, and enjoyment of the MVP in the next DSR cycle

The identified design features and employees' feedback on the first prototype form the basis for the development of the MVP of the envisioned gamified application in the second DSR cycle.

# Second DSR Cycle: MVP Development and Formative Evaluation

# 9 MVP Development of a Gamified App for Sustainable Employee Behavior



**Acceptance criteria and design constraints.**

User stories can be refined with acceptance criteria. Acceptance criteria can be understood as "conditions of satisfaction" [556] for the realization of a user story. While they work well for functional requirements, user stories and acceptance criteria often cannot adequately address technical aspects and non-functional requirements that constrain the design [557]. Therefore, if such aspects are identified during the evaluation, they are added as design constraints to the respective user stories (Table 9.2) or the overall application (Table 9.1).

[556]: Leffingwell *et al.* (2011)

[557]: Medeiros *et al.* (2017)

## 9.1 Definition of Objectives/Suggestion

Evaluating the artifact through in-depth conversations with employees about their motivations for sustainable behavior, their expectations for utilitarian, social, and hedonic design features, and their feedback on the click dummy developed in Chapter 7 has led to valuable insights about how to improve the envisioned gamified application in the second DSR cycle.

Following the DSR paradigm, the first step in the second DSR cycle is to refine objectives and suggestions for the artifact as a basis for subsequent design and development. Following the user story approach of the first DSR cycle, the existing user stories are refined and expanded by the findings of the preceding evaluation and then prioritized for implementation in the MVP to be developed in this cycle. Specifically, existing user stories are specified in acceptance criteria and design constraints are added based on employee suggestions and feedback.

Table 9.2 summarizes how the previous user stories are refined and extended in this DSR cycle. The following section details the derivation of refinements and added user stories based on the previous evaluation. For each user story, the associated design feature expectations, positive impressions of the click dummy, and areas of improvement mentioned by evaluation participants are considered to derive acceptance criteria and design constraints. In case certain aspects are not yet included in a user story, a new user story is added, resulting in a total of 23 user stories for further design and development of the gamified application.

In line with the prevailing egoistic motivations for sustainable behavior, the employees emphasized the role and implementation of utilitarian aspects in the gamified application.

**US1:** As a user, I want to set goals for sustainable behavior.

Regarding **US1**, employees emphasized that they like to receive predefined, clear, and achievable goal suggestions (P10, P13, P14, P16, P19, P23, P26) from which they can choose to tailor their goals (P2, P4, P8, P18, P21, P22, P23). They also wanted the ability to sort and filter suggested goals (P2, P11) and to browse all goals in the application (P7). In particular, some employees indicated that they would like to receive daily goal suggestions (P4, P18, P20). Regarding the design constraints for US1, staff mentioned that suggested goals should be clearly separated from current goals (P1) and that goals should be illustrated with appropriate images (P3, P13, P16, P20, P22, P26).

**US2:** As a user, I want to get a positive feedback message when I behave sustainably.

In the case of **US2**, employees did not place great demands on the design of positive feedback in the gamified application, but some emphasized that they would like to see a juicy message with animations when performing a sustainability action (P3, P8, P14).

**US3:** As a user, I want to gain points when I behave sustainably.

As for **US3**, employees liked the idea of earning points when they perform a sustainability action (P3, P4, P9, P12, P14, P19, P20, P21, P26). In addition, they indicated that they would like to see clearly in advance how many points they can earn from a particular action (P2) and that they would like to see plainly what progress they are making toward their goals as they earn points (P2, P9, P11, P21, P26).

**US4:** As a user, I want to see how much points I earned in different categories.

In terms of **US4**, employees emphasized that they liked the sustainability profile with a chart showing how many points they scored in the different categories of sustainable behavior (P6, P10, P11, P12, P14, P15, P19). However, they also defined a number of design constraints to implement the categories more clearly. First, they wanted a clarification of the categories (P2, P4, P6, P17, P20, P24) and proposed four categories: emissions, energy, water, and waste (P4). In addition, the categories should be illustrated with appropriate colors (P9, P13, P14, P15, P19, P20, P22, P23, P26) and symbols (P13, P14, P15, P19, P20, P22, P23, P26), which did not seem suitable in the click dummy. In particular, staff mentioned that the colors of the categories should be chosen so that they do not indicate performance (P7, P8, P20).

**US5:** As a user, I want to see my progress in a level system.

At **US5**, employees liked the idea of moving up in a level system as they accumulate points (P3, P4, P9, P12, P14, P19, P20, P21, P26), and they emphasized that they wanted to have their progress in the level system be transparently displayed (P14, P20). However, it should be noted that the scaling and relevance of the level system should be explicitly explained (P4, P5, P6, P15, P19, P25). One employee also mentioned that each level should be given a title or designation (P26).

**US6:** As a user, I want to earn badges for specific achievements.

**US6** refers to badges for specific achievements, and employees expected to receive virtual badges for specific achievements (P3, P4, P7, P9, P13, P15, P20, P25, P26). In addition, they desired transparency of their progress toward earning a badge (P5, P6, P9, P10, P11, P14, P17). Regarding design constraints, badges should be linked to a clear milestone that is transparently explained

(P5, P6, P9, P10, P11, P14, P17), and badges should have different difficulties (P6, P12, P13, P15, P19).

**US7:** As a user, I want to see the impact of my behavior.

Concerning **US7**, almost all employees liked the idea of a dashboard where they could see the key metrics saved by all users of the company (P1, P2, P3, P4, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P20, P22, P23, P25, P26, P27). They added that they wanted to see the timeframe of key metrics (P4, P5) as well as trend indicators for their performance (P4, P25), and that they also desired to see the personal sustainability metrics they had saved individually (P6, P10, P11, P12, P14, P15, P19). To this end, they suggested being able to switch between company and personal statistics on the dashboard (P11). Regarding design constraints, employees emphasized that the dashboard should clearly indicate to whom the metrics refer - to the company or to the individual user (P2, P4, P5, P6, P7, P10) - and that the abstract units of the metrics should be clarified (P2, P4, P6, P17, P20, P24).

**US8:** As a user, I want to receive notifications and reminders that nudge me towards sustainable behavior.

With respect to notifications and reminders (**US8**), employees indicated that they would like to receive reminders in the form of push notifications (P1, P12, P18, P19, P20, P22, P25, P26) on their smartphones.

**US9:** As a user, I want to get guided which actions I can take to achieve my goals.

For **US9**, employees mentioned two aspects. On the one hand, employees requested an overview of all sustainability actions they can take in their daily work (P7, P8, P11, P12, P20). On the other hand, they emphasized that they would like to receive personalized recommendations for sustainability actions based on their goals (P5, P9, P10, P12, P20, P23, P25, P26). In this context, they stressed that both the connection (P3, P5, P6, P7, P8, P19, P20, P24) and the difference (P1, P8, P9, P10, P11, P12, P13, P14, P15, P16, P20, P22, P26) between goals and actions should be made clearer, which could be due to the nomenclature of ”challenges”.

**US10:** As a user, I want to receive tips on how to behave sustainably.

Regarding **US10**, employees requested to receive information about sustainable behavior during the working day (P1, P2, P4, P10, P13, P17, P18, P22, P25, P26). In addition, they stated that they would like to play quizzes about sustainable behavior to increase their knowledge (P3, P6, P7).

In addition to these user stories that were already defined in the first DSR cycle, the evaluation reveals three additional user stories as new functional requirements that are added to the existing ones for this design and development cycle.

**US19:** As a user, I want to receive an introductory onboarding when using the application for the first time.

Employees indicated that they would like to see an introduction or walk-through when using the application for the first time to understand its purpose and features (P7, P14, P15, P21, P22, P26). In addition, one employee added that this onboarding should also be accessible later while using the application (P26).

**US20:** As a user, I want to track my actions for sustainable behavior with minimal effort.

Employees added a main point that was not previously considered, namely the effort required to track their behavior in the system. They noted that they wished to quickly access the screen to track their actions (P15, P16, P19, P22, P24, P25) and to do so with as few clicks as possible (P4, P6, P9, P11, P15, P16, P17, P21, P22, P25). To do this, employees wanted to be able to easily favor actions (P1, P6, P9, P12, P13) and undo them if they made a mistake (P1). In the best case, the system would automatically track actions taken outside of the application so that employees do not have to manually enter anything (P6, P24). As a design constraint, some employees mentioned that they would like to see the sustainability actions on the home page (P1, P9, P11, P20, P25).

**US21:** As a user, I want to earn tangible rewards for specific achievements.

While the decision to use virtual achievements was based on the context of the intervention, several employees mentioned that they would like to receive tangible rewards from their company for their sustainability performance in the application (P3, P9, P10, P12, P19, P21, P27). In addition, they mentioned donations to non-profit organizations as an alternative (P1, P5).

For the social aspects of the gamified application, employees did not mention many design constraints, but they did add some acceptance criteria to the existing user stories indicating how they should be implemented in the next DSR cycle.

**US11:** As a user, I want to see other users' profiles.

Regarding **US11**, employees indicated that they would like to have user profiles with information about their performance (P16) and the ability to explore other users' profiles (P11, P13). In particular, some staff added that they wished to be able to like or comment on other users' performances (P8, P12, P26).

**US12:** As a user, I want to see how I perform in comparison to others.

In terms of social comparison (**US12**), employees expected a leaderboard (P1, P3, P4, P5, P6, P10, P12, P19, P20) and the ability to start direct competitions with other users (P1, P2, P5, P12, P14, P18, P21, P26). In addition, employees wanted the ability to compare their key metrics with others (P1, P6, P7, P10, P13, P14, P16, P25). As a design constraint for the leaderboard, one employee mentioned that it would be good to keep the idea of displaying only the top 10 users (P20).

**US13:** As a user, I want to organize myself with colleagues in teams.

Concerning social collaboration (**US13**), users enjoyed the idea of organizing themselves into teams with others (P1, P2, P5, P6, P7, P8, P15, P16, P18, P20). In addition, two employees stated that they would be pleased to communicate directly with colleagues via a messaging system (P4, P23).

**US14:** As a user, I want to customize my presentation.

In **US14**, employees desired the ability to customize their personal profile (P8, P20), and they appreciated being able to present their achievements to others (P11). As an additional idea, they mentioned that they would also like to share their achievements on social media (P1, P26).

In addition to these predefined user stories specified by the evaluation, employees mentioned another new aspect related to social interaction that is added as a new user story:

**US22:** As a user, I want to share my knowledge on sustainable behavior with others.

Employees emphasized that they wished to share their knowledge about sustainability in the workplace with their colleagues by suggesting sustainability actions (P4, P5, P6, P17, P21, P24, P27). They also would like to see a voting function where they can vote on which sustainability actions suggested by other users should be included in the application (P3, P8).

As already concluded in Chapter 8, he employees mentioned less hedonic than utilitarian aspects for the design of the application, which could also be due to a lack of knowledge about design options. However, they did make some suggestions for refining the existing user stories.

**US15:** As a user, I want to be able to make personal settings for the applications' functionalities.

Regarding settings (**US15**), no employees explicitly mentioned that they would like the option to personalize notifications, but several employees mentioned that settings should be accessible from the profile page rather than the main screen (P1, P4, P8, P19). In addition, several employees added that they would like the ability to customize the dashboard to show specific categories or a specific focus - the entire company or the individual user (P1, P11, P16).

**US16:** As a user, I want to unlock new content when I progress in the application.

To unlock new content (**US16**), staff appealed to the idea of finding unexpected Easter Eggs when they reach certain achievements (P2, P6, P20), and that they can unlock more difficult sustainability actions when they obtain certain accomplishments (P4, P9, P21, P25).

**US17:** As a user, I want to see continuous new content in the application.

For continuous new content besides unlocking content (**US17**), employees had two main suggestions. First, they proposed including new sustainability actions in the application during specific promotional periods, e.g., on a specific theme (P1, P14, P20, P25, P26). Second, they suggested including new sustainability action proposals based on the current season (P1, P14, P20, P25, P26).

**US18:** As a user, I want to choose from different actions that I can perform for sustainability.

In order to be able to choose between multiple paths and options (**US18**), employees wanted detailed information on sustainability actions that explained the impact of the actions (P5, P13). In addition, employees desired the ability to browse all actions (P10) and to filter and sort actions according to their needs (P4, P11). As a design constraint, employees noted that the system should clearly link actions to categories (P12).

In addition to these predefined user stories specified by the evaluation, employees mentioned one new aspect related to hedonic experience that is added as a new user story:

**US23:** As a user, I want to receive emotional reinforcement when I behave sustainably.

In addition to utilitarian reminders and cues that primarily serve to educate employees about sustainable behavior, employees also wish for additional motivational messages that encourage them to engage in sustainable behavior on an emotional level (P1, P8, P9, P18).

In addition to these rather functional suggestions, employees also mentioned a variety of aspects related to technical or aesthetic constraints of the gamified application that do not relate to specific user stories, but rather affect the entire application, as shown in Table 9.1. These non-functional (NF) suggestions are considered as additional design constraints for the next design cycle and are grouped into four different categories: easy access, seamless experience, data security and fraud protection, and brand customization.

**NF1:** Easy access

The design constraints identified in terms of access to the gamified application relate to the form of the application and its integration. Most employees preferred a smartphone application (P2, P3, P4, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P20, P21, P22, P24, P26, P27), while some employees added that they would also like a browser application

Table 9.1: Non-functional design constraints affecting the entire application that emerged based on the artifact evaluation in the first DSR cycle.

| Category | Design constraints |
|---|---|
| **NF1**: Easy access | ▸ The system should be implemented in form of a smartphone application (P2, P3, P4, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P20, P21, P22, P24, P26, P27)<br>▸ The system should be implemented in form of a browser application (P2, P10, P16, P17, P20, P22, P24, P26)<br>▸ The system should be integrated with existing systems in the corporate environment (P24, P26)<br>▸ The system should be available in German and English (P1) |
| **NF2**: Seamless experience | ▸ The system should have a clear and intuitive structure (P1, P2, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P18, P19, P20, P21, P22, P23, P24, P25, P26, P27)<br>▸ The system should have a visible and easy navigation in one direction (P9, P10, P11, P15, P16, P18, P19, P20, P27)<br>▸ Navigation points and symbols should be clearly explained (P21, P22, P25)<br>▸ The system should include a back button (P10, P16)<br>▸ The system should use overlays for actions and goals (P11, P15, P20)<br>▸ The system should have a modern design without shadows (P7, P9, P15, P25)<br>▸ The system should use fresh colors (P11, P12)<br>▸ The level status on the start page should link to the profile (P7, P8, P10, P14, P19, P20, P21) |
| **NF3**: Data security and fraud protection | ▸ The system should include control mechanisms to prevent fraud (P1, P8, P12, P15, P27)<br>▸ The system should include a consent form for data processing (P17, P22)<br>▸ The system should protect data from external access (P17) |
| **NF4**: Brand customization | ▸ The system should be customized to the brand of the company (P2, P8, P26) |

(P2, P10, P16, P17, P20, P22, P24, P26). For optimal access, the application should be integrated with the company's existing systems (P24, P26), and to accommodate the diversity of employees, the application should be available in German and English (P1).

**NF2:** Seamless experience

Employees noted several aspects related to the experience of working with the user interface, criticizing aspects of the click dummy that should be improved in the MVP. In particular, the application should have a clear and intuitive structure (P1, P2, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P18, P19, P20, P21, P22, P23, P24, P25, P26, P27) and the navigation should be prominent and intuitive, following only one direction (P9, P10, P11, P15, P16, P18, P19, P20, P27). In this context, navigation points and icons should also be clearly explained (P21, P22, P25) and the application should include a back button for easier navigation (P10, P16). In terms of aesthetics, staff noted that the use of overlays for actions and goals is appropriate (P11, P15, P20), but the system should have a modern design without shadows

(P7, P9, P15, P25) and use fresh colors (P11, P12). As a usability comment, several employees particularly expected the level status on the home page to be linked to the profile (P7, P8, P10, P14, P19, P20, P21).

**NF3:** Data security and fraud protection

Data privacy and security emerged in the interviews as a new topic of particular importance in the corporate environment (Chapter 8). Employees noted that the system should include control mechanisms to prevent fraud (P1, P8, P12, P15, P27) and ensure a fair environment. In addition, the application should include a consent form for data processing (P17, P22) and ensure that data is protected from outside access (P17).

**NF4:** Brand customization

As a final aspect, some employees desired that the application be customized to the company's brand to foster a sense of connectedness between the application and the corporate environment (P2, P8, P26).

The following Table 9.2 again illustrates how the previously described user stories are refined and extended in this DSR cycle.

Table 9.2: Refined user stories based on the artifact evaluation in the first DSR cycle (added information is marked in green).

| User story | Acceptance criteria | Design constraints |
|---|---|---|
| **Utilitarian:** User stories that guide towards the intended behavioral outcomes | | |
| **US1:** As a user, I want to set goals for sustainable behavior. | ▸ The user receives different predefined, clear and achievable goal suggestions (P10, P13, P14, P16, P19, P23, P26)<br>▸ The user can select from different goal suggestions in order to customize their goals (P2, P4, P8, P18, P21, P22, P23)<br>▸ The user can sort and filter goal suggestions (P2, P11)<br>▸ The user can browse all goals in the application (P7)<br>▸ The user receives varying daily goal suggestions (P4, P18, P20) | ▸ Suggested goals should be clearly separated from current goals (P1)<br>▸ Goals should be illustrated with appropriate pictures (P3, P13, P16, P20, P22, P26) |
| **US2:** As a user, I want to get a positive feedback message when I behave sustainably. | ▸ The user sees a juicy feedback message with animations when they perform a sustainability action (P3, P8, P14) | |
| **US3:** As a user, I want to gain points when I behave sustainably. | ▸ The user receives points when they perform a sustainability action (P3, P4, P9, P12, P14, P19, P20, P21, P26)<br>▸ The user can see how much points can be earned by a particular action (P2)<br>▸ The user can see the current progress in a goal based on the points earned (P2, P9, P11, P21, P26) | |

Table 9.3: Refined user stories based on the artifact evaluation in the first DSR cycle (added information is marked in green) (continued).

| User story | Acceptance criteria | Design constraints |
|---|---|---|
| **US4:** As a user, I want to see how much points I earned in different categories. | ▸ The user can see a personal sustainability profile with a diagram that displays how many points they have earned in different categories (P6, P10, P11, P12, P14, P15, P19) | ▸ Categories should be clearly explained (P2, P4, P6, P17, P20, P24)<br>▸ The system should have four categories: emissions, energy, water and waste (P4)<br>▸ Categories should be illustrated with suitable colors (P9, P13, P14, P15, P19, P20, P22, P23, P26)<br>▸ Category colors should be selected in such way that they do not indicate performance (P7, P8, P20)<br>▸ Categories should be illustrated with suitable icons or symbols (P13, P14, P15, P19, P20, P22, P23, P26) |
| **US5:** As a user, I want to see my progress in a level system. | ▸ The user progresses in a level system when they earn points (P3, P4, P9, P12, P14, P19, P20, P21, P26)<br>▸ The user can see their progress in the level system (P14, P20) | ▸ The scaling and relevance of the level system should be clearly explained to the user (P4, P5, P6, P15, P19, P25)<br>▸ Each level should be given a title or designation (P26) |
| **US6:** As a user, I want to earn badges for specific achievements. | ▸ The user earns virtual badges for certain achievements (P3, P4, P7, P9, P13, P15, P20, P25, P26)<br>▸ The user can see their progress towards a badge (P5, P6, P9, P10, P11, P14, P17) | ▸ Badges should be linked to a clear milestone that is transparently explained (P5, P6, P9, P10, P11, P14, P17)<br>▸ Badges should have variable difficulties (P6, P12, P13, P15, P19) |

Table 9.3: Refined user stories based on the artifact evaluation in the first DSR cycle (added information is marked in green) (continued).

| User story | Acceptance criteria | Design constraints |
|---|---|---|
| **US7:** As a user, I want to see the impact of my behavior. | ▸ The user can see a dashboard with key metrics saved by all users of a company (P1, P2, P3, P4, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P20, P22, P23, P25, P26, P27)<br>▸ The user can see the timeframe of the key metrics on the dashboard (P4, P5)<br>▸ The user can see personal sustainability statistics with key metrics saved by them (P6, P10, P11, P12, P14, P15, P19)<br>▸ The user can switch between company and personal sustainability statistics on the dashboard (P11)<br>▸ The user can see trend indicators for sustainability statistics (P4, P25) | ▸ It should be clear to whom the key performance indicators relate (P2, P4, P5, P6, P7, P10)<br>▸ Abstract units of the key metrics should be clearly explained (P2, P4, P6, P17, P20, P24) |
| **US8:** As a user, I want to receive notifications and reminders that nudge me towards sustainable behavior. | ▸ The user receives reminders for sustainable behavior in the form of push notifications (P1, P12, P18, P19, P20, P22, P25, P26) | |
| **US9:** As a user, I want to get guided which actions I can take to achieve my goals. | ▸ The user can see an overview of sustainability actions they can take in their daily work (P7, P8, P11, P12, P20)<br>▸ The user receives personalized recommendations for sustainability actions (P5, P9, P10, P12, P20, P23, P25, P26) | ▸ The link between goals and actions should be clearly illustrated (P3, P5, P6, P7, P8, P19, P20, P24)<br>▸ The difference between goals and actions should be clearly explained (P1, P8, P9, P10, P11, P12, P13, P14, P15, P16, P20, P22, P26) |
| **US10:** As a user, I want to receive tips on how to behave sustainably. | ▸ The user receives informational hints about sustainable behavior throughout the workday (P1, P2, P4, P10, P13, P17, P18, P22, P25, P26)<br>▸ The user can play quizzes about sustainable behavior (P3, P6, P7) | |
| **US19:** As a user, I want to receive an introductory onboarding when using the application for the first time | ▸ The user sees an introductory onboarding on first use (P7, P14, P15, P21, P22, P26)<br>▸ The user can access the onboarding later during use (P26) | |

Table 9.3: Refined user stories based on the artifact evaluation in the first DSR cycle (added information is marked in green) (continued).

| User story | Acceptance criteria | Design constraints |
|---|---|---|
| **US20**: As a user, I want to track my actions for sustainable behavior with minimal effort | ▸ The user can quickly access the screen to track their actions for sustainability (P15, P16, P19, P22, P24, P25)<br>▸ The user can track actions with one click (P4, P6, P9, P11, P15, P16, P17, P21, P22, P25)<br>▸ The user can easily favor actions (P1, P6, P9, P12, P13)<br>▸ The user can undo actions (P1)<br>▸ The system automatically tracks actions that a user performs outside of the application (P6, P24) | ▸ All actions for sustainability should be displayed on the start page (P1, P9, P11, P20, P25) |
| **US21**: As a user, I want to earn tangible rewards for specific achievements. | ▸ The company can give users tangible rewards for their sustainable behavior (P3, P9, P10, P12, P19, P21, P27)<br>▸ The company can make donations to non-profit organizations based on users' achievements (P1, P5) | |
| **Social:** User stories that enable social interaction and positive social effects | | |
| **US11:** As a user, I want to see other users' profiles. | ▸ The user can see a personal profile with information on their performance (P16)<br>▸ The user can explore other users' profiles (P11, P13)<br>▸ The user can like and comment other users' achievements (P8, P12, P26) | |
| **US12:** As a user, I want to see how I perform in comparison to others. | ▸ The user can see a leaderboard (P1, P3, P4, P5, P6, P10, P12, P19, P20)<br>▸ The user can measure themselves in direct competitions with other users (P1, P2, P5, P12, P14, P18, P21, P26)<br>▸ The user can compare their key metrics with others (P1, P6, P7, P10, P13, P14, P16, P25) | ▸ The leaderboard should only show the top 10 users (P20) |
| **US13:** As a user, I want to organize myself with colleagues in teams. | ▸ The user can organize themselves with other users in teams (P1, P2, P5, P6, P7, P8, P15, P16, P18, P20)<br>▸ The user can communicate with others via messages (P4, P23) | |

Table 9.3: Refined user stories based on the artifact evaluation in the first DSR cycle (added information is marked in green) (continued).

| User story | Acceptance criteria | Design constraints |
|---|---|---|
| **US14:** As a user, I want to customize my presentation. | ▸ The user can customize their personal profile (P8, P20)<br>▸ The user can present their achievements to others (P11)<br>▸ The user can share their achievements on social media (P1, P26) | |
| **US22:** As a user, I want to share my knowledge on sustainable behavior with others. | ▸ The user can suggest sustainability actions (P4, P5, P6, P17, P21, P24, P27)<br>▸ The user can vote for sustainability actions suggested by other users (P3, P8) | |
| **Hedonic:** User stories that foster individual relevance | | |
| **US15:** As a user, I want to be able to make personal settings for the applications' functionalities. | ▸ The user can make settings on notifications<br>▸ The user can customize the dashboard (P1, P11, P16) | ▸ The settings should be accessible from the profile page (P1, P4, P8, P19) |
| **US16:** As a user, I want to unlock new content when I progress in the application. | ▸ The user unlocks Easter Eggs when reaching specific achievements (P2, P6, P20)<br>▸ The user unlocks more difficult sustainability actions for specific achievements (P4, P9, P21, P25) | |
| **US17:** As a user, I want to see continuous new content in the application. | ▸ The user receives suggestions for certain sustainability actions in specific promotional periods (P1, P14, P20, P25, P26)<br>▸ The user receives suggestions for certain sustainability actions based on the season (P1, P14, P20, P25, P26) | |
| **US18:** As a user, I want to choose from different actions that I can perform for sustainability. | ▸ The user can see detailed information on sustainability actions that explains the effect of the action (P5, P13)<br>▸ The user can browse all actions (P10)<br>▸ The user can filter and sort actions (P4, P11) | ▸ The system should clearly link actions to categories (P12) |
| **US23:** As a user, I want to receive emotional reinforcement when I behave sustainably. | ▸ The user receives motivational messages that encourage sustainable behavior (P1, P8, P9, P18) | |

## 9.2 MVP Design and Development

Based on the refined user stories and additional design constraints derived from the initial evaluation of the artificial artifact, design and development in the second DSR cycle include the design of a more naturalistic artifact that aims to provide deep insights into the user experience of using the artifact [103].

[103]: Venable *et al.* (2016)

[558]: Lenarduzzi *et al.* (2016)

In this regard, a MVP, which based on the results of a systematic review of MVP definitions [558] can best be described as a version of a new product that has only the features necessary for the product to be deployed in order to gather the maximum amount of validated insights about potential users with the least amount of effort, is a particularly appropriate approach to gathering feedback from early adopters [558]. Rather than attempting to implement and satisfy all user stories and requirements for the final product, the approach, which originated in lean startup and agile software development [559], prioritizes requirements and focuses on those that provide the greatest value to users [560].

[559]: Anderson *et al.* (2017)

[560]: Tripathi *et al.* (2019)

In the following, background information on the technical implementation of the gamified application MVP is first provided, followed by a detailed description of how the refined user stories and design constraints are prioritized and translated into the user interface design of the MVP during this design and development phase.

### 9.2.1 Technical Implementation

**App development frameworks.**

You can find more information on the different app development frameworks noted in the text on the respective websites:

- ReactNative: `https://reactnative.dev/`
- Ionic: `https://ionicframework.com/`
- Flutter: `https://flutter.dev/`
- NativeScript: `https://nativescript.org/`

The previous evaluation showed that most employees voted in favor of implementing the gamified application in the form of a smartphone application (**NF1**). Therefore, although some employees also wanted a browser application or integration with existing systems, the development of a smartphone application is prioritized in this design and development cycle. As a first requirement, the development framework should allow simultaneous development for Android and iOS operating systems, so that all potential users with different devices in the companies can use the gamified application with the least possible implementation effort.

There are several cross-platform app development frameworks for developing apps that are usable on different systems with just one code base, such as *ReactNative* from Meta, *Ionic* from Drifty Co, *Flutter* from Google, and *NativeScript* from nStudio. They differ in the programming languages used as well as in their cross-platform approach. For a comparative overview of the different app development frameworks, see Table 9.4.

**Table 9.4:** Overview of app development frameworks for cross-platform app development.

| Name | ReactNative | Ionic | Flutter | NativeScript |
|---|---|---|---|---|
| Supported mobile operating systems | Android & iOS | Android & iOS | Android & iOS | Android & iOS |
| Programming language | JavaScript | JavaScript | Dart | JavaScript |
| Cross-platform approach [561] | Interpreted | Hybrid | Cross-compiled | Interpreted |

Of all these frameworks that would generally be suitable for implementing the gamified application, ReactNative was chosen for development due to my familiarity with JavaScript based on pre-existing development knowledge, ability to implement the requirements, and long-term maintainability.

In terms of development *complexity*, it can be seen from Table 9.4 that ReactNative, Ionic, and NativeScript are based on JavaScript, while Flutter is based on the Dart programming language. Since I have developed with JavaScript before in the form of a React application, Flutter was excluded to reduce the effort of learning a new programming language for implementation.

Regarding the *ability to implement the requirements*, one particular design constraint is the *seamless experience* (**NF2**), which, in addition to the design of the application, also refers to the look-and-feel experience when using the application, especially in terms of structure and navigation. Research has shown that hybrid apps, unlike interpreted apps, can cause look-and-feel inconveniences and are more reminiscent of websites than native apps, which can affect the user experience [562]. Since Ionic uses the hybrid approach [561], it was excluded to provide a native user experience.

[562]: Ahti *et al.* (2016)

[561]: Biørn-Hansen *et al.* (2020)

ReactNative and NativeScript use similar approaches, but in terms of *maintainability*, ReactNative is supported by Meta, and thus there is little risk that the framework will not be developed further in the future [563]. Considering that ReactNative is also the most used cross-platform app development framework alongside Flutter [564], I therefore chose ReactNative as the app development framework for the MVP.

[563]: Rieger *et al.* (2019)

[564]: JetBrains (2022)

[565]: Kumar (2019)

For the backend architecture of the application, it was very important that the chosen implementation complies with the standards of the European Data Protection Regulation, thus ensuring *data security* (**NF3**). At the same time, in order to have the best protection against potential security breaches and to ensure that the application scales seamlessly with fluctuating traffic (with high peaks expected in the registration phases), the use of existing backend-as-a-service providers with pre-existing services for e.g. user registration and encrypted password storage, which have already been approved by a large number of customers, was preferred over a custom backend implementation. There are many different backend-as-a-service providers, such as *Amazon AWS Amplify*, *Google Firebase* and *Microsoft Azure Mobile Apps*. In this project, I chose AWS because they can be considered the leader in serverless apps, offer a variety of helpful services [565], and the implementation of the backend functions can be done on a JavaScript basis.

**Backend-as-a-service providers.**

You can find more information on the different backend-as-a-service providers noted in the text on the respective websites:

- AWS Amplify: https://aws.amazon.com/de/amplify/
- Google Firebase: https://firebase.google.com/
- Microsoft Azure Mobile Apps: https://azure.microsoft.com/de-de/products/app-service/mobile/

Figure 9.1[5] shows the architecture of the gamified application with the AWS services used. AWS Amplify is a toolkit that helps developers create and manage application backends in the AWS Cloud. It provides a command line interface that enables the creation and configuration of cloud services so that, for example, a database table can be set up by running a predefined command line interface command and defining a database schema. In addition, AWS Amplify provides the necessary libraries to communicate with the cloud resources that are created. These libraries are available for many different programming languages and frameworks, including ReactNative.

[5] AWS services icons taken from https://aws.amazon.com/de/architecture/icons/).

Features such as user authentication and authorization when accessing data and caching are already implemented in the Amplify libraries, so there is no need to develop standard functionality.

As cloud services, I use Amazon Cognito user pools for authentication and user management, Amazon Simple Email Service to send double-opt-in user verification mails, AWS Lambda functions for running backend code in the cloud (e.g., calculating user points after performing an action for sustainability), Amazon S3 buckets for storing files (especially images), and an Amazon DynamoDB database (a NoSQL database that stores all the required data). AWS AppSync is a GraphQL API that allows Amplify to access and modify data from the DynamoDB database and Lambda backend functions.

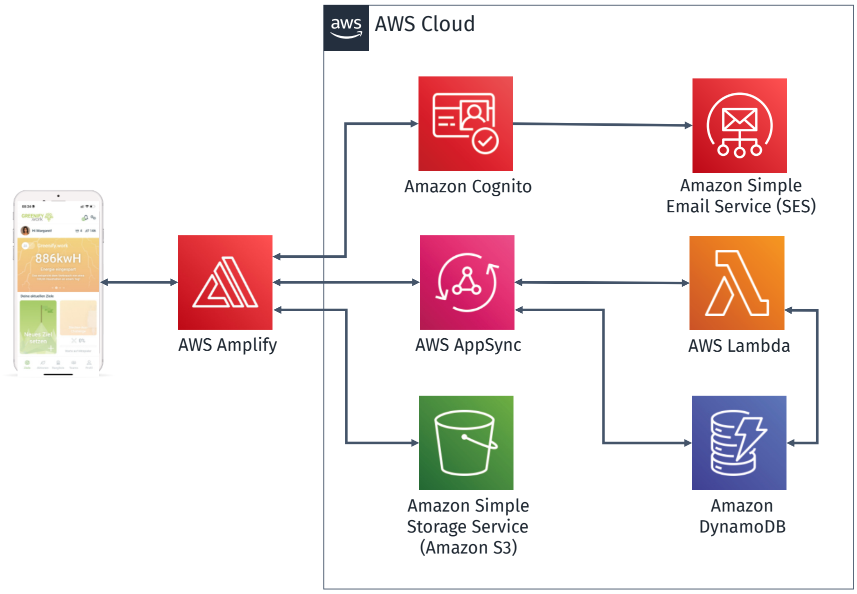


Figure 9.1: Backend architecture of the gamified application.

### 9.2.2 User Interface Design

In the following, I will explain how the individual user stories summarized in Table 9.5, together with the specified acceptance criteria as well as design constraints, and the non-functional design constraints Table 9.1, are considered in the design of the MVP. In general, utilitarian user stories are prioritized over social and hedonic user stories, as employees mainly cited egoistic motivations for sustainable behavior and emphasized that the gamified app needs to provide utilitarian value, such as clear goals and guidance, rather than hedonic value (see Chapter 8). Moreover, such user stories that are critical to developing the core functionality of the gamified app (such as setting goals and achieving them by performing actions) are prioritized over additional features that can be added in the second version of the gamified app (such as badges or rewards).

From the non-functional design constraints, as already described, the system is implemented in the form of a smartphone application and made available in German and English for *easy access* (**NF1**). The browser application format is technically possible with the chosen tech stack, but similar to the integration with enterprise systems, not prioritized for the MVP.

Table 9.5: User stories and their implementation in the MVP.

| User story | Priority | Included in MVP? | Implementation |
|---|---|---|---|
| **Utilitarian:** User stories that guide towards the intended behavioral outcomes | | | |
| **US1:** As a user, I want to set goals for sustainable behavior. | **High**: Core functionality | √ | Figure 9.3 |
| **US2:** As a user, I want to get a positive feedback message when I behave sustainably. | Medium: Juicy animations can be added in 2nd version | √ | Figure 9.6 |
| **US3:** As a user, I want to gain points when I behave sustainably. | **High**: Core functionality | √ | Figure 9.6 |
| **US4:** As a user, I want to see how much points I earned in different categories. | Medium: Category overview can be added in 2nd version | √ | Figure 9.7 |
| **US5:** As a user, I want to see my progress in a level system. | **High**: Core functionality | √ | Figure 9.6, Figure 9.7 |
| **US6:** As a user, I want to earn badges for specific achievements. | Medium: Badges can be added in 2nd version | × | |
| **US7:** As a user, I want to see the impact of my behavior. | **High**: Core functionality | √ | Figure 9.7 |
| **US8:** As a user, I want to receive notifications and reminders that nudge me towards sustainable behavior. | Medium: Notifications can be added in 2nd version | (√) | Figure 9.8 |
| **US9:** As a user, I want to get guided which actions I can take to achieve my goals. | **High**: Core functionality | √ | Figure 9.4, Figure 9.8 |
| **US10:** As a user, I want to receive tips on how to behave sustainably. | Medium: Additional tips can be added in 2nd version | × | |
| **US19:** As a user, I want to receive an introductory onboarding when using the application for the first time | Low: Introduction in pilot phase is done by researcher | × | |
| **US20:** As a user, I want to track my actions for sustainable behavior with minimal effort | **High**: Core functionality | √ | Figure 9.5 |
| **US21:** As a user, I want to earn tangible rewards for specific achievements. | Low: Cannot be realized without company support | × | |
| **Social:** User stories that enable social interaction and positive social effects | | | |
| **US11:** As a user, I want to see other users' profiles. | Medium: Profile view can be added in 2nd version | (√) | Figure 9.7 |
| **US12:** As a user, I want to see how I perform in comparison to others. | **High:** Social feature most emphasized by employees | √ | Figure 9.3, Figure 9.9 |
| **US13:** As a user, I want to organize myself with colleagues in teams. | Medium: Team organization can be added in 2nd version | (√) | Figure 9.3 |
| **US14:** As a user, I want to customize my presentation. | Medium: Customization can be added in 2nd version | (√) | Figure 9.10 |
| **US22:** As a user, I want to share my knowledge on sustainable behavior with others. | Medium: Knowledge sharing can be added in 2nd version | × | |
| **Hedonic:** User stories that foster individual relevance | | | |
| **US15:** As a user, I want to be able to make personal settings for the applications' functionalities. | Medium: Advanced settings can be added in 2nd version | √ | Figure 9.7, Figure 9.10 |
| **US16:** As a user, I want to unlock new content when I progress in the application. | Medium: Focus on functionality rather than content in the MVP | × | |
| **US17:** As a user, I want to see continuous new content in the application. | Medium: Focus on functionality rather than content in the MVP | × | |
| **US18:** As a user, I want to choose from different actions that I can perform for sustainability. | **High**: Core functionality | √ | Figure 9.4, Figure 9.5 |
| **US23:** As a user, I want to receive emotional reinforcement when I behave sustainably. | Medium: Focus on functionality rather than content in the MVP | × | |

To provide a *seamless experience* (NF2), the click dummy navigation is reworked and titles for navigation icons are added, iOS and Android gestures are implemented for easy backward navigation, overlays for actions and goals are retained, the level status on the home page is linked to the profile, and the overall design is reworked to use fresher colors and eliminate shadows.

For *data security and fraud protection* (NF3), a registration process is implemented to ensure that only users with authorized email addresses (domains of participating companies) can register, see and agree to a data processing consent form, and receive a double opt-in to create an account (Figure 9.2). In addition, only **authorized** users can see and access their **own** company's data, so that the data is protected from external access.

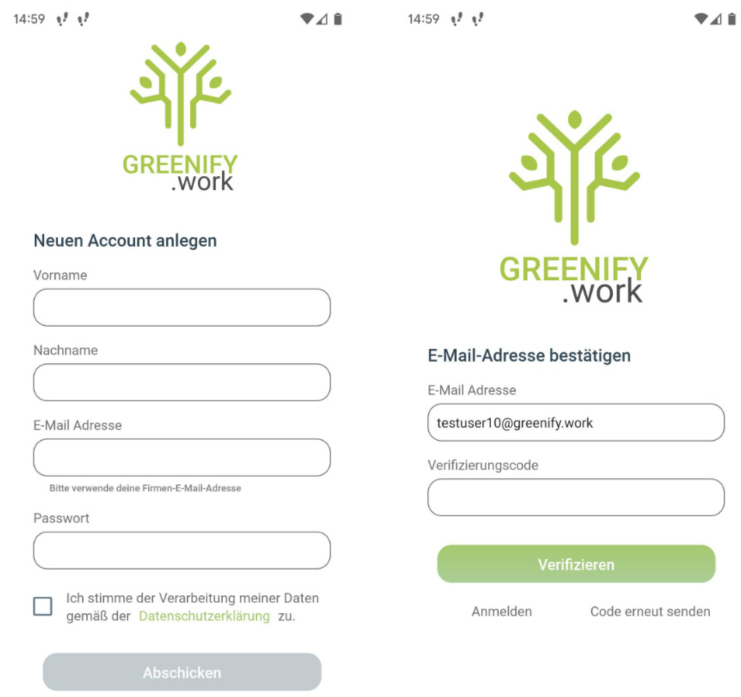


Figure 9.2: Screenshots of the registration process in the MVP (NF3).

Finally, for *brand customization* (NF4), the company logo is inserted as the main design element in the application header, which is visible in all screens.

Regarding functional requirements, the first and most important user story is to *set goals for sustainable behavior* (US1). In accordance with the acceptance criteria, the goal setting process was designed to allow users to *customize their goals* by a) selecting a type of goal (team goal, competition, or individual goal, left side of Figure 9.3) and b) choosing from three different goal suggestions that *vary each time* users set a goal and that are *predefined to be clear and achievable* (right side of Figure 9.3). These goal suggestions can be *filtered by category* and *re-rolled to get new suggestions*. In addition, users can *search all goals* in the application using the search bar at the bottom. Goals are *illustrated with images* and *color-coded by category* to facilitate identification with the goal. By designing the goal-setting process as a guided wizard, it also *clearly separates itself from the overview of current goals*.

To achieve their goals, users can take actions on sustainability. To *guide users on what actions they can take to achieve their goals* (US9), users

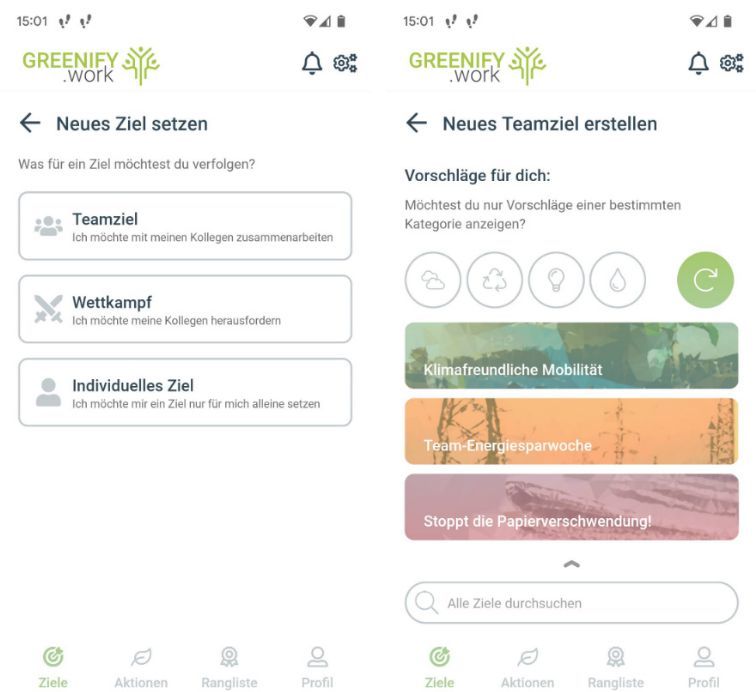


Figure 9.3: Screenshots of the goal setting process in the MVP (**US1**, **US12**, **US13**).

can see an *overview of sustainability actions* on the actions page (Figure 9.4). On this page, users also receive six *personalized recommendations* on which actions match their current goals, and can *re-roll these suggestions* to get new ideas for sustainability actions. To *clarify the link between goals and actions* while *separating goals and actions as two distinct constructs*, users can also access all actions that contribute to a goal on the goal detail page and favorite them for later use (left side of Figure 9.8). To accommodate *freedom of choice in sustainability actions* (**US18**), users can also *browse all actions sorted by category* (right side of Figure 9.4) and *access detailed information about each sustainability action* that explains the action's impact by sliding up the modal at the bottom (Figure 9.5). Similar to goals, actions are color-coded to provide a *clear link between actions and categories*.

Ensuring that users can *track their actions for sustainable behavior with minimal effort* (**US20**), they can *track their action with one click* in the modal that opens when an action is selected, and *favorite an action by clicking on the heart icon* in the same modal, eliminating the need to navigate to the detail page that was necessary in the click dummy (left side of Figure 9.5). The action page is linked in the main navigation of the application to ensure that users can *quickly access the screen to track their actions*. However, I decided against displaying the actions on the home page to emphasize the effect achieved rather than the actions. For the MVP, *undoing actions* and *automatic tracking* is not a priority.

When an action is performed, users receive a *juicy feedback animation* (**US2**) with the newly added avatar Leafy (left side of Figure 9.6). Users *receive points* (**US3**) displayed in the feedback modal (left side of Figure 9.6), and can see *current progress in a goal* based on points earned on the goal detail page (right side of Figure 9.6). In addition, users can already see *how many points they can earn by performing a certain action* on the action page (Figure 9.4). Similarly, in the feedback modal, users can see *how far they progressed in the level system* by earning points (**US5**).

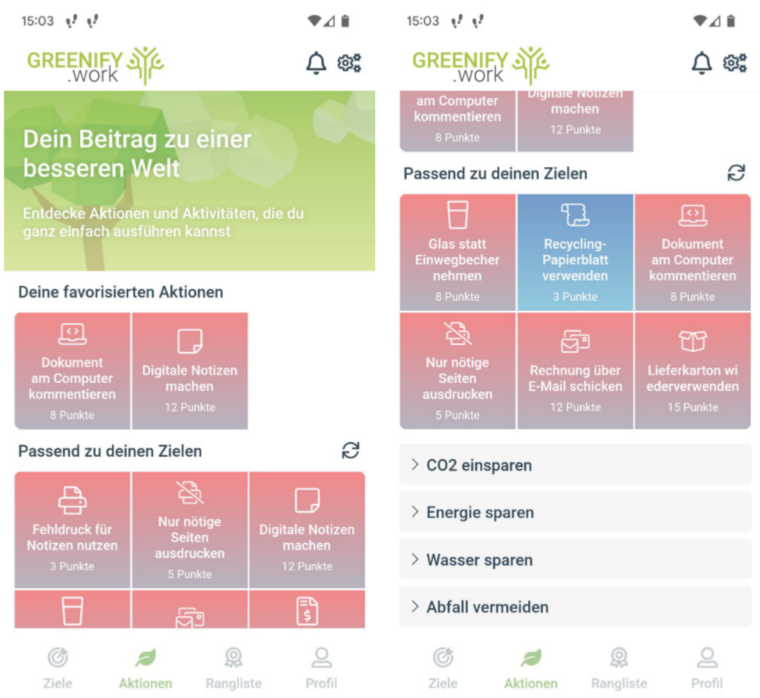


**Figure 9.4:** Screenshots of the actions screen in the MVP (US3, US9, US18).


**Figure 9.5:** Screenshots of the action selection process in the MVP (US18, US20).

**Font Awesome.**

Font Awesome is one of the largest icon libraries for designers and applications. You can find more information here: `https://fontawesome.com/`

In their personal profile (left side of Figure 9.7), users can *view their progress in the level system* at any time (**US5**). The indication of the remaining points until the next level serves to *make the scaling of the level system clear* to the users. However, level titles are omitted in the MVP. In addition, users can see *a personal sustainability profile that shows how many points they have earned in the different categories* on their profile (**US4**). According to the design constraints, the application includes *four categories*: emissions, energy, water, and waste, all of which are represented with a *color gradient* (to avoid suggesting performance like a traffic light) and a matching *Font Awesome icon*.

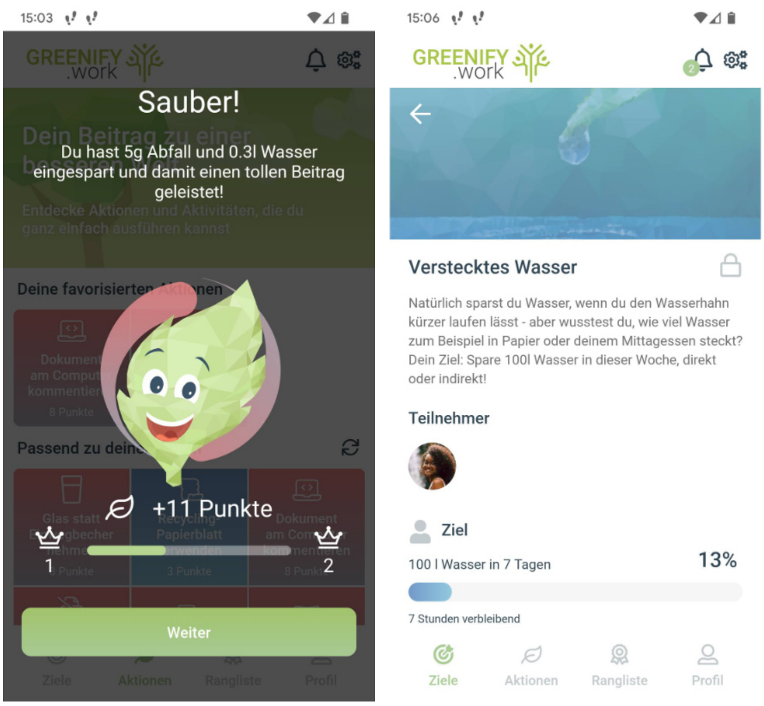


Figure 9.6: Screenshots of the feedback animation and goal progress MVP (US2, US3, US5).

On the start screen (right side of Figure 9.7), the categories are further illustrated with an *appropriate graphical element*. The start screen (right side of Figure 9.7) is also important for users to *see the impact of their behavior* (US7). Users see a sliding *dashboard of key metrics saved by all users of the company*, as well as *their personal statistics* in each of the four categories. Using the small switch in the upper left, users can *toggle between company and personal sustainability statistics*, and the label on the switch makes it clear *to whom the metrics relate*. Since the units of the categories, such as kWh of energy, are difficult to understand, the *key metrics are explained with concrete examples* and thus converted as kilometers driven by car (emissions), bathtub capacity (water), and household consumption per day (energy and waste). *Trend indicators* are not prioritized for the MVP.

A slimmed-down version of *notifications and reminders that encourage users to engage in sustainable behavior* (US8) is implemented in the MVP. Users receive *push notifications* when they are invited to a goal, start a goal, achieve a goal, or fail to achieve a goal (right side of Figure 9.8). However, *motivational messages and additional tips* (US10, US23) are not included in the MVP as a priority, because their implementation requires generating a lot of content, which will be added in the next version.

In terms of social user stories, the *user profile* basis (US11) is implemented in the form of users being able to *see a personal profile with information about their performance* and goals achieved in the past (left side of Figure 9.7). However, *exploration of and interaction with other users' profiles* is postponed to the next version.

To enable *social comparison* (US12), a *leaderboard* is implemented and linked in the main navigation (left side of Figure 9.9). According to the design constraints, the leaderboard *shows only the top 10 users* and one's own position at the bottom of the screen. By selecting competitive goals (left side of Figure 9.3), users can also *compete directly with other users*


Figure 9.7: Screenshots of the profile and start screens in the MVP (US4, US5, US7, US11, US15).

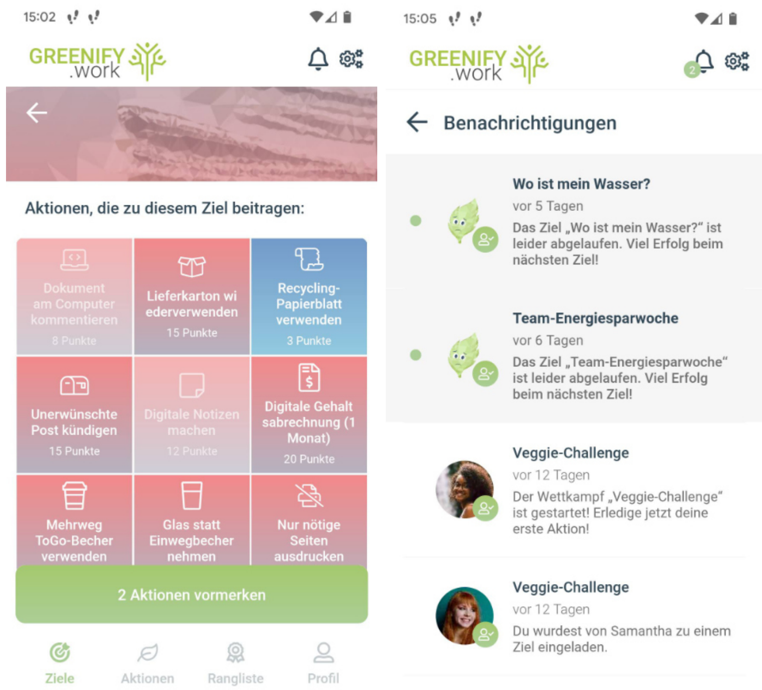


Figure 9.8: Screenshots of the action suggestion screen and notifications in the MVP (US8, US9).

(right side of Figure 9.9). However, in the MVP, users cannot yet *directly compare their key metrics with others*.

*Team organization* (US13) is also implemented in a trimmed down version in the MVP. By selecting team goals (left side of Figure 9.3), users can *work in teams to achieve a common goal*. However, they still cannot *organize themselves into different teams* or *communicate with others* independently of the goals.

For *customization* (US14), users can tailor their personal profile by *setting a profile picture and specifying their display name* (left side of Figure 9.10).

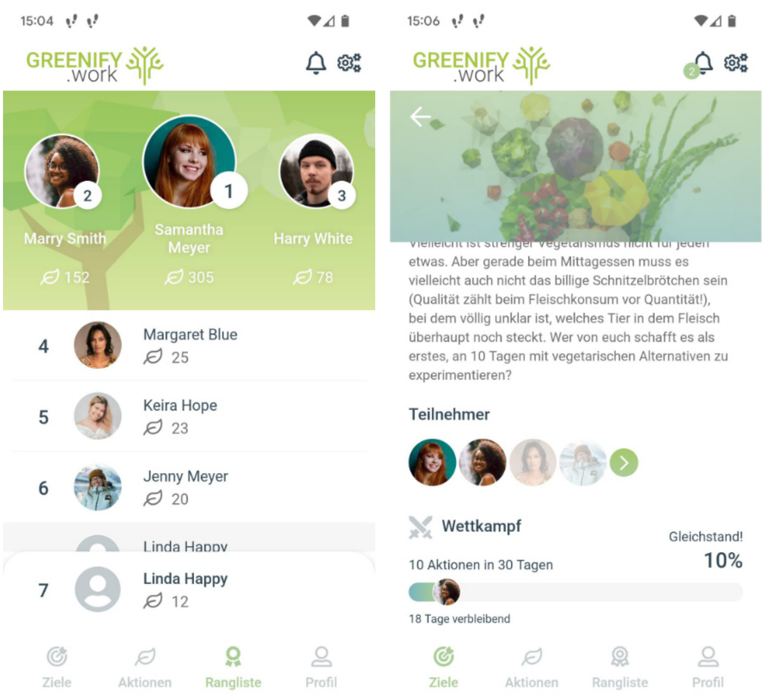


**Figure 9.9:** Screenshots of the leaderboard and an exemplary competition in the MVP (**US12**).

However, since viewing other users' profiles (**US11**) is not yet implemented in the MVP, the presentation is still limited to the users themselves and they cannot yet *present or share their achievements to others*.

In terms of hedonic user stories (beyond **US18**), users can *configure personal settings for the app's features* (**US15**) via a detailed settings page that allows *specifying preferences for each type of notification* (right side of Figure 9.10). The switch on the dashboard (right side of Figure 9.7) also allows users to *determine whether they want to see their own or the company statistics* on the start screen. For easier access, it is decided to keep the settings in the header instead of hiding them on the profile page.

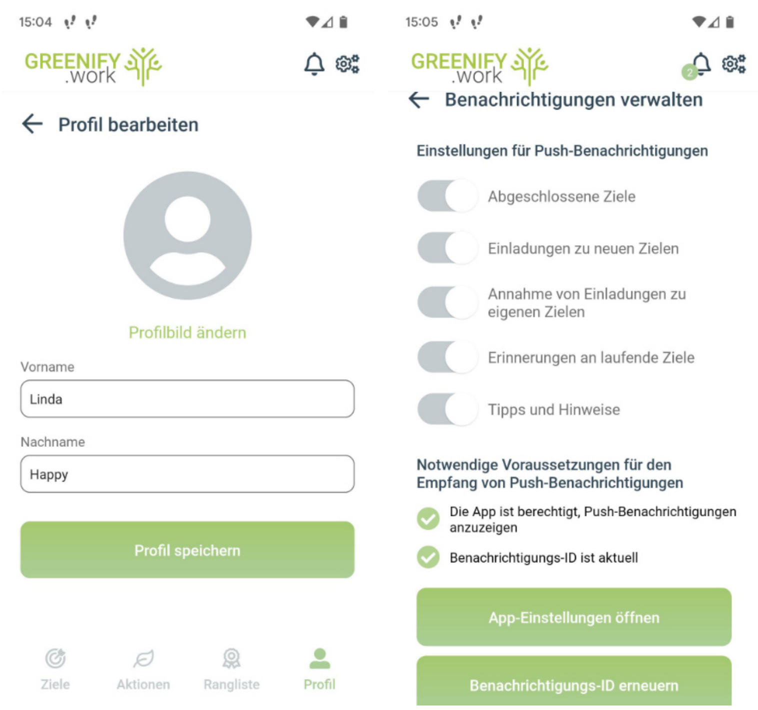


**Figure 9.10:** Screenshots of the profile editing screen and the settings in the MVP (**US14, US15**).

As explained in Table 9.5, **US16** and **US17** are not prioritized for the MVP because *unlocking Easter eggs and actions* would require a huge amount of content that is beyond the scope of the MVP, which focuses on the most important features needed for the application with the least effort [558]. Similarly, *badges* (**US6**), *tips* (**US10**), and *motivational messages* (**US8**) are deferred, and only a set of 50 actions and 12 sustainability goals are included in the app, with a major expansion of content planned for the next version. Also, because the second evaluation is conducted with only a small focus group, *knowledge sharing* is not prioritized (**US22**), and since the introduction in the pilot phase is done by the researcher, *introductory onboarding* to the application (**US19**) is not included in the MVP. Finally, *tangible rewards* (**US21**) that would require strategic support from the company are also not implemented in the pilot phase.

[558]: Lenarduzzi *et al.* (2016)

In summary, the design and development of the MVP carefully considers the user stories derived from the initial evaluation of the click dummy. 11 out of 23 user stories are fully implemented in the MVP, and another 4 user stories are partially implemented and will be further developed in the next version. Thus, the MVP represents a suitable version of the application that includes the user stories with the greatest value (especially the utilitarian value most emphasized by employees in the first evaluation) for the users [566]. The following Chapter 10 presents the results of the evaluation of this developed artifact as the conclusion of the second DSR cycle.

[566]: Tripathy *et al.* (2020)

# Study 5: Challenges in the Use of the Gamified App from Employees' Perspective 10




**Publication of this study.**

The content of this study has been submitted for publication in adapted and shortened form to the International Journal of Information Management.


## 10.1 Context and Aim of this Study

In-depth consideration of employee motivations for sustainable behavior and their expectations for the design features of a gamified app for sustainability at work based on both conceptual discussion and evaluation of the initial non-functional prototype has guided the design of the MVP of the gamified app for sustainable employee behavior at work in the second DSR cycle. Following the FEDS framework, the developed artifact is now undergoing formative evaluation in the real-world [103] environment. The goal is to gain deep insights into employees' experiences using the gamified application, with a particular focus on the challenges they encountered during implementation and use, and their ideas on how to overcome these challenges when shaping the gamified application in the next DSR cycle.

The effectiveness and impact of any green IS depends on its successful implementation and on its adoption and use by users [567]. Organizational adoption of green IS has been explored in the literature primarily through evolving empirical research models based on a top-down approach from technical, administrative, governmental, and institutional perspectives [40]. It can be seen that understanding the adoption of IS still depends on whether the previously explored acceptance-related antecedents and dimensions would continue to influence the adoption of green IS [195]. However, the similarities and ambiguities among the various existing dimensions and contextual influences complicate a holistic analysis of green IS adoption motivation, intention, and behavior [40], [213]. More importantly, due to the lack of meaningful qualitative studies [40], these important but unknown dimensions of influence have not received appropriate attention [195]. To address this research problem, particularly in the organizational context, this study aims to *provide meaningful insights and a deeper understanding of green IS adoption by exploring the potential challenges, difficulties, and dilemmas* of using the developed gamified application for sustainable employee behavior at work. In addition, it attempts to discuss possible solutions for these difficulties and challenges with the employees in order to derive design suggestions for the further development of the artifact.

To pursue this goal, this work draws on the DOI [214] and activity theory [290] as a theoretical framework to qualitatively examine the challenges and dilemmas that arise from green IS for sustainable behavior in organizational contexts from the employee perspective. First, DOI allows consideration of the social change process in the adoption of the gamified application [568], thereby shedding light on the incremental stages of individual decision-making towards adoption. Second, activity theory serves as a theoretical lens to explore the sociotechnical environment of the adoption and use of the gamified application [291], which is particularly valuable to analyze human interactions with a system, as opposed to overemphasizing the technology itself [569]. A combination of deductive and inductive interpretive phases are consequently used to understand

[103]: Venable *et al.* (2016)

[567]: Dwivedi *et al.* (2022)

[195]: Papagiannidis *et al.* (2022)

[40]: Singh *et al.* (2020)

[213]: Marikyan *et al.* (2019)

[214]: Rogers (2003)

[290]: Engeström (2015)

[568]: Allen (2000)

[291]: Karanasios (2018)

[569]: Allen *et al.* (2013)

*when* (in the individual technology adoption process) and *why* (due to which dimensions of the sociotechnical environment) *which* challenges arise. In addition, *overarching themes* that can be identified that hinder the adoption and use of green IS in organizational settings are summarized and discussed in light of possible design solutions from the employees' perspective.

## 10.2 Theoretical Background

### 10.2.1 Adoption and Use of Green IS

As outlined in Chapter 3, extensive work on the adoption and use of green IS has examined both the drivers and challenges to green IS adoption, primarily using positivist methods and drawing on predefined factors and determinants from theories of technology adoption, such as the TAM [118].

[118]: Davis (1989)

However, previous studies on both the drivers of adoption and the challenges failed to adequately understand the user perspective of green IS adoption, and there are few studies that consider the cognitive process of technology adoption [213]. For example, Ijab et al. [570] examined the process of implementing and using green ISs in a large telecommunications company and found that once the benefits of green ISs are recognized, there are several implementation approaches that can subsequently lead to continued use of green IS. Schmermbeck et al. [215] analyzed the processes of green IT and green IS adoption in organizations and identified different societal, organizational, or individual drivers in the pre-adoption phase, followed by an adoption (use) and post-adoption (continued use) phase. Yet, both studies focused on the adoption process from an organizational rather than an individual perspective. Notably, a study by Sanguinetti et al. [211] explored how demographic characteristics and perceived benefits and barriers can predict the stage of the innovation decision process in smart home adoption, and thus represents a first attempt to consider individual cognitive processes relevant to the adoption of green IS. Overall, despite efforts to understand the adoption and use of green IS, critical shortcomings exist:

[570]: Ijab (2019)

[215]: Schmermbeck (2019)

[211]: Sanguinetti *et al.* (2018)

(1) First, most research has focused on the factors of technology adoption and the drivers of technology acceptance, which is a good basis for understanding the adoption of green IS, but does not adequately consider the sustainability context and user perspective in evaluating green IS throughout the adoption life cycle [195].

[195]: Papagiannidis *et al.* (2022)

(2) Second, an organizational perspective on the adoption of green IS is prevalent in all aspects of adoption research, whether related to adoption factors, challenges, or the adoption process, which requires a more comprehensive view of users' perceptions and motivations [40], [213] that goes beyond positivist endorsement of existing technology acceptance models.

[40]: Singh *et al.* (2020)
[213]: Marikyan *et al.* (2019)

(3) Third, existing studies that have taken an individual perspective on challenges or adoption processes [211], [213] have focused on household contexts as opposed to organizational contexts. Although insights from these related contexts are valuable in advancing knowledge about green IS

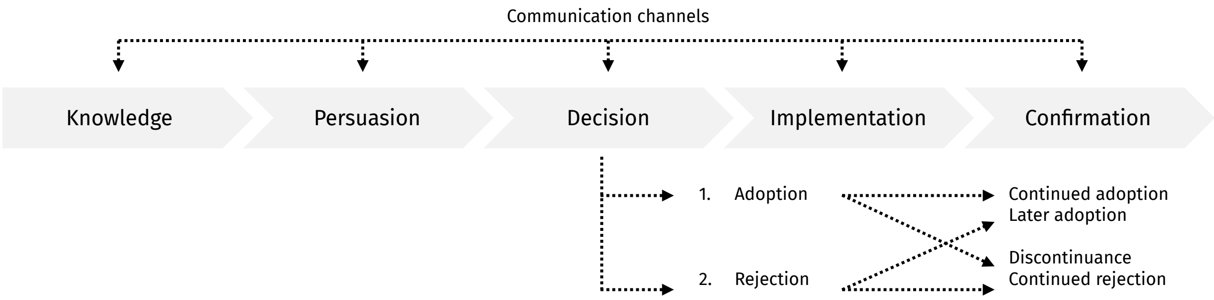


**Figure 10.1:** A model of stages in the innovation-decision process (adapted from [214, p.165]).

adoption, they do not take into account the specifics of the organizational context that may pose challenges to green IS adoption from the employee's perspective or affect their individual adoption process.

(4) Finally, to the best of the author's knowledge, there are no studies that combine consideration of individual cognitive processes of green IS adoption and use with a particular perspective on the challenges posed by the tension between the organizational context and the topic of sustainability. Drawing on both the DOI [214] and activity theory [290], this study aims to advance theoretical understanding of green IS adoption among employees in organizations by building on and combining previous work on processes of green IS adoption, barriers and challenges to adoption, and the specifics of organizational context.

[214]: Rogers (2003)

[290]: Engeström (2015)

## 10.2.2 Diffusion of Innovations Theory

Because IS are technology-based innovations introduced to people in a social system, innovation research is a valuable tool for understanding the process of IS adoption as a process of social change [568]. In particular, the DOI [214] has been widely used in IS research as a theoretical lens to study IS adoption and diffusion [571]. DOI posits that an individual's decision to adopt an innovation is a process consisting of five sequential phases [214] (see Figure 10.1). The DOI's five phases have parallels to Prochaska's TTM [485] and McGuire's hierarchy of effects [572], supporting the assumption that these phases do exist [214].

[568]: Allen (2000)

[571]: Jha *et al.* (2016)

[485]: Prochaska *et al.* (1992)

[572]: McGuire (1989)

Individuals begin in the *knowledge* phase, where they are first exposed to a new innovation and understand how it generally works at three levels: *Awareness-Knowledge* refers to the knowledge that the innovation exists, *How-to-Knowledge* describes the understanding of how to properly use the innovation, and *Principles-Knowlegde* consists of the knowledge of what operating principles the innovation is based on [214].

Once individuals have acquired sufficient knowledge about the innovation, they enter the *persuasion* phase, in which they form positive or negative attitudes toward the innovation [214]. The persuasion phase differs from the knowledge phase primarily in that the knowledge phase is conceptualized as primarily cognitive, whereas the persuasion phase is affective and relates more to a feeling toward the innovation [214]. However, once individuals have formed a positive or negative attitude toward the innovation, it is not directly transformed into a subsequent change in behavior [214]. Rather, a discrepancy between attitude and behavior often occurs, referred to as the attitude-intention-behavior gap [573]. This discrepancy is particularly pronounced in the case of environmentally friendly behavior [574]. Thus, the *decision* phase follows, in which individuals undertake activities that lead to an active decision for or against the innovation [214].

[573]: Sheeran *et al.* (2003)

[574]: Kollmuss *et al.* (2002)

[214]: Rogers (2003)

In the subsequent *implementation* phase, individuals translate the results of the mental decision process of the first three phases into behavior, i.e., they begin to use the innovation [214].

However, the implementation phase is not the end of the process. In the *confirmation* phase, which may continue indefinitely after the introduction of an innovation [214], individuals continually seek confirmation of the decision they have already made and may reverse that decision if they are exposed to conflicting messages or experiences that cause dissonance [214]. In addition, disengagement may also result from substitution of the innovation for perceived better solutions or from dissatisfaction with its performance [214].

DOI theory is particularly valuable to this research in understanding when in the individual decision-making process a particular challenge to adopting green IS occurs. In line with urgent calls for innovation research in IS [571], I rely on DOI theory to cover multiple stages of the innovation adoption process that help understand how challenges in the overall ecosystem in organizations influence the adoption of green IS for sustainability in the organizational context.

[571]: Jha *et al.* (2016)

### 10.2.3 Activity Theory

In 1978, Vygotsky postulated that human behavior is not a mere response to a stimulus, as behaviorism assumed at the time, but the result of a mediated psychological act in which tools or signs mediate the relationship between a stimulus and a response [338]. Based on this work, which considered human behavior for the first time as an activity triad rather than a linear response, [290] developed the activity triad model to describe the structure of human activity, his main contribution being to include social aspects in the activity system [575]. The activity-theoretic system consists of a *subject* (the individual himself) acting toward an *object* (the goal toward which the activity is directed), mediated by *instruments* (tools and signs) and influenced by a social system of *rules*, *community*, and *division of labor* (see figure Figure 10.2).

[338]: Vygotsky (1978)

[290]: Engeström (2015)

[575]: Holt *et al.* (1993)

Specifically, community refers to an interdependent conglomeration of individuals who share, to some degree, a set of social meanings. Rules refer to incomplete guidelines for activities or actions provided by this community, while division of labor represents the task specialization of members within this community [575].

One of the most important contributions of an activity theory perspective in IS research is that it links technology (as instruments) and the organizational and social context, providing a sociotechnical perspective [291]. In IS research [576] and especially in human-computer interaction research [577], activity theory has proven to be a valuable lens for analyzing human behavior and interactions with IS.

[291]: Karanasios (2018)

[576]: Karanasios *et al.* (2015)

[577]: Clemmensen *et al.* (2016)

In an application to this research, activity theory presents a useful angle to distinguish between challenges in adopting green IS that occur at the

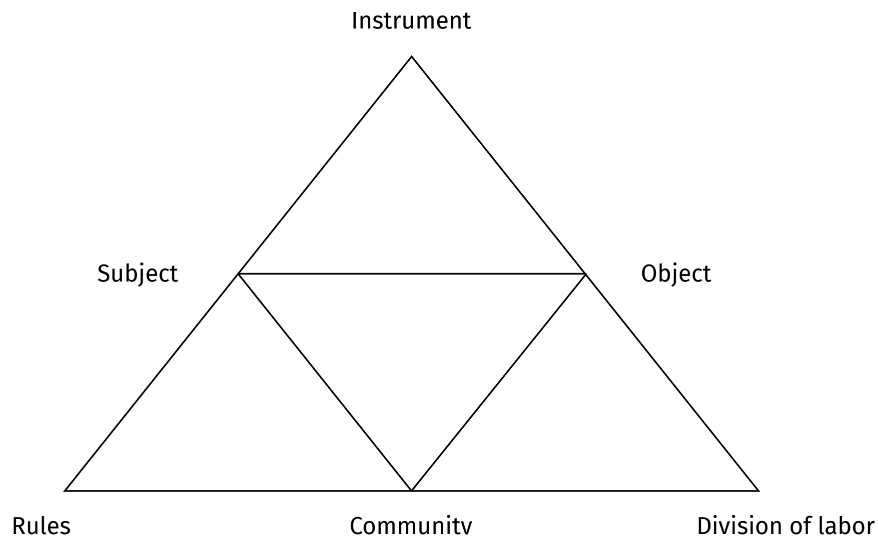


Figure 10.2: The structure of human activity (adapted from [290, p.63]).

level of the subject (the individual employee), the object (sustainable behavior as a target behavior), the instrument (the green IS itself), and the community (the organizational environment of the employees including their peers as community members, organizational rules, and division of labor). Using activity theory as a perspective in IS adoption research allows not to overemphasize technology, but instead to carefully consider the sociotechnical system in which the adoption occurs [569].

[569]: Allen *et al.* (2013)

## 10.3 Research Method

Following the guide to research design in qualitative research by [543], the methodological choices in terms of methodological fit, philosophical perspective, methods, methodology, data collection, and data analysis, as shown in the figure Figure 10.3, are explained below.

[543]: Makri *et al.* (2021)

Since the main research question is to investigate in depth what challenges are encountered in the process of adopting green IS and how to overcome them, it is in line with the main purpose of *exploratory research* to investigate what happens in real phenomena [543].

**RQ 1:** *Which challenges impede the adoption of green IS in organizational contexts?*

**RQ 2:** *Which design features can help overcome these challenges?*

Regarding the *philosophical perspective*, IS research usually distinguishes between positivist, interpretive, and critical epistemology [578]. Positivist studies generally aim to test certain theoretical assumptions and formal propositions, whereas interpretive studies seek to understand phenomena through the meanings people assign to them [579]. Critical research aims primarily to uncover constraining and alienating conditions of the status quo in contemporary society [579]. Since interpretive research *"aims to*

[578]: Orlikowski *et al.* (1991)

[579]: Myers (1997)

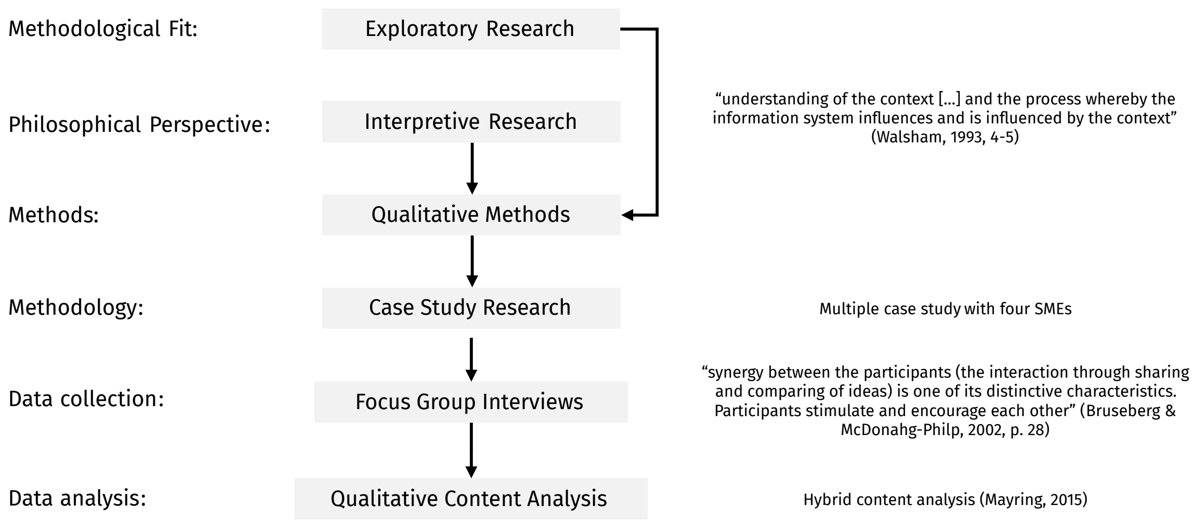


Figure 10.3: Research design of the present study.

*create an understanding of the context of the information system and the process by which the information system influences and is influenced by the context"* [544, p. 4-5], the *interpretive perspective* is eminently suitable for addressing the research questions.

[544]: Walsham (1993)

The interpretive philosophical perspective guided the choice of *method*, opting for a *qualitative* as opposed to a quantitative approach [579]. The goal of qualitative research is to *"understand[ing] issues or particular situations by investigating the perspectives and behavior of the people in these situations and the context within which they act"* [545, p. 30]. Qualitative research methods may include action research, ethnography, or case study research [579].

[579]: Myers (1997)

[545]: Kaplan *et al.* (2005)

*Case study research* represents one of the most common qualitative research *methodologies* in IS research [578]. Case studies are generally appropriate when the research goal is to examine a particular phenomenon in a real-world context, especially when the boundaries between phenomenon and context are not apparent [580]. Case study research is particularly viable in IS research because it allows researchers to study IS in a natural setting, to understand the nature and complexity of the processes taking place, and to gain new theoretical insights in areas where there have been few studies [581]. To combine the advantages of case study research, but also to overcome the limitations of biases that arise from looking at individual cases [130], a *multiple case study* approach to triangulate the results by obtaining data from different companies using the same green IS was chosen. Four small and medium-sized companies in Germany that implemented the MVP of the gamified application over a three-week period in April-May 2022 were selected.

[578]: Orlikowski *et al.* (1991)

[580]: Yin (1981)

[581]: Benbasat *et al.* (1987)

[130]: Adams *et al.* (2008)

*Data collection* in case study research can include multiple data collection methods, such as observation, analysis of written artifacts, individual interviews, or focus group interviews [581]. *Focus groups* can particularly improve the quality of human-computer interaction and IS research because of their synergistic potential [130], as they often provide data that are rarely obtained through individual interviews and observation, leading to particularly powerful findings [132]. In general, focus groups are a group of

[132]: Kamberelis *et al.* (2013)

individuals who come together to discuss a particular topic. The main goal is to stimulate interaction and the sharing and comparison of experiences to gain comprehensive insights into opinions and motivations for behavior [131]. To gain insight into the challenges employees experienced in adopting green IS and to benefit from the synergies achieved through group discussions, *four focus group interviews* with three to six employees who used the application during the study period were conducted, following the recommendations for focus groups [130]. Details of the data collection process and participants are provided in the respective sections.

[131]: Bruseberg *et al.* (2002)

[130]: Adams *et al.* (2008)

Finally, regarding *data analysis*,the qualitative coding approach [545] was chosen together with a combination of *deductive qualitative content analysis* of [549] as one of the most appropriate approaches to extract insights from qualitative data in relation to a predefined research question under consideration of an appropriate theoretical framework [548] and *inductive qualitative content analysis* [549] to extract themes from the deductively coded categories. Details of the data analysis are explained in the corresponding section below.

[545]: Kaplan *et al.* (2005)

[549]: Mayring (2014)

[548]: Mayring (2019)

### 10.3.1 Data Collection

The purposeful selection of cases is essential for rigorous case study research, especially when multiple cases are selected to triangulate data from different sources [581]. To ensure a basic homogeneity of the selected cases, I focused on *small and medium-sized companies in Germany*. Second, companies from *different industries* were selected to ensure consideration of the diversity of business practices in small and medium-sized enterprises that may affect workplace routines and the associated challenges for employees in adopting and using green IS. To account for the social dynamics that are an important factor in the human activity system [290] and that may vary by company size, companies of *different sizes* were included. Finally, I focused particularly on *employees working in offices* (as opposed to manufacturing or skilled trades), since the gamified application focuses particularly on sustainability actions that can be taken in office spaces in terms of instructional characteristics.

[581]: Benbasat *et al.* (1987)

[290]: Engeström (2015)

Table 10.1 shows the final cases selected for this research. Company A is an industrial technology provider with approximately 250 employees from various sectors, with a focus on engineering and software development. Their product relates to circular economy and recycling, and according to their own presentation, environmental sustainability is already embedded in their culture. Company B is an industrial software provider with 400 employees who are mainly software developers due to their core B2B software product. Company B is making various sustainability efforts, such as offsetting its emissions, using green power, and switching to electric vehicles, but its employees have not been as involved in its sustainability strategy. Company C is a glass manufacturer with approximately 150 employees. The majority of these employees work in the production halls and often come from abroad or have little education. In administration, about 30 employees work in research and development, procurement, sales, marketing and process optimization. The company attaches great importance to the recycling and reuse of its glass products and environmentally compatible production, but is particularly interested in new approaches to creatively involve its employees and motivate them to adopt sustainable behavior.

**Table 10.1:** Overview of selected companies for case study research.

| Designation | Type | No. of employees | Engagement in corporate sustainability |
|---|---|---|---|
| Company A | Industrial technology provider | ± 250 | Core activities related to the circular economy, anchored in the corporate culture |
| Company B | Industrial software provider | ± 400 | CO2 compensation, green power and electric vehicles |
| Company C | Glass manufacturer | ± 150 | Climate-friendly production and focus on recycling |
| Company D | Web design agency | ± 30 | Awareness of sustainability, but no action so far |

Finally, Company D is a web design agency with 30 employees, mainly software developers and UX designers. Environmental sustainability has gained importance for them as a key criterion of responsible and sustainable digitization. However, the company is not yet engaged in efforts for sustainability.

Focus groups of 5-6 employees were recruited in each of the companies, selected by company representatives to reflect the diversity of gender, age, and job positions in each company. Thus, the representatives of each company selected the participants themselves and approached them through the company's own channels. Participants were given a description of the objectives and method of the study before making a decision and then voluntarily agreed to participate. Before using the gamified application, preliminary interviews regarding their motivations for sustainable behavior were conducted. After three weeks of using the gamified application, focus group participants were invited to participate in a focus group interview (taking place in May 2022) in which 3-6 employees attended (Company A: 3/5, Company B: 5/6, Company C: 4/5, Company D: 6/6), what can be considered as appropriate in light of existing recommendations for focus group size [130]. Due to differences in Covid-19 regulations across the companies, three focus group interviews (Companies B, C, and D) were conducted on-site and one focus group interview (Company A) was conducted online via Microsoft Teams. All interviews were recorded using multiple devices in the room or audio recording software. The focus group interviews lasted 66 minutes (Company C), 94 minutes (Company A), 95 minutes (Company D), and 97 minutes (Company B), respectively, excluding the introduction and conclusion, which were not recorded, and were carried out in German.

[130]: Adams *et al.* (2008)

The focus group interviews were moderated based on a predefined guideline. First, as an easy introductory question, employees were asked how often they used the gamified application during the three weeks. After an initial sharing of the positive experiences while using the gamified application (in terms of the features that were most motivating and how the gamified application supported sustainable behaviors), the conversation moved to the challenges that were encountered while using the gamified application. Specifically, participants were first asked to write down obstacles they faced on post-its for themselves, followed by an in-depth discussion of their experiences based on their own and their colleagues' post-its. In this context, they also discussed explicitly when in the adaptation and use process of the gamified application these difficulties arose. To conclude with a solution-oriented approach, the last part of the focus group interviews asked employees to reflect on what would need to change for them personally in terms of their work environment, their individual circumstances, or the design of the gamified application in order for them to overcome the challenges discussed. After the focus group interviews were conducted, the recordings were manually transcribed and translated into English, and the transcripts served as the basis for the data analysis.

### 10.3.2 Participants

The participants in the focus group interviews were diverse in terms of gender, age, position, and job description in their companies. Six participants considered themselves female and twelve participants considered themselves male. Ages ranged from 19 to 42 years old. In addition to demographic data, all participants indicated that sustainability is an important and pressing issue for them, but they cited different motivations for sustainable behavior. Most employees named individual or egoistic motivations, such as a good feeling and their children's future, while others mentioned social pressure and changing awareness in society as main motivations. Only four participants stated intrinsic concern for the biosphere and the environment as the main driver for sustainability. Regarding the adoption and use of the green IS during the study, most participants indicated that they used the gamified application daily or multiple times a week, while only three participants used it rarely or very irregularly. There was no participant who did not adopt and use the gamified application at all. However, seven participants also indicated that their usage decreased significantly over time and they stopped using it after one or two weeks. Table 10.2 shows an overview of the participants.

### 10.3.3 Data Analysis

On the basis of the transcribed focus group interviews, hybrid qualitative content analysis following the methodological suggestions of Mayring [549] was performed using MAXQDA as qualitative data analysis tool. First, deductive coding is particularly aimed at subdividing and analyzing values of predefined theoretical structuring dimensions [549], which can be considered suitable to structure challenges in the adoption of green IS at the workplace in accordance with the theoretical lenses. The deductive coding process involved (1) defining the categories to be coded (in this case, the five stages of the innovation adoption process [214] and the six dimensions of the human activity system [290]), (2) developing category definitions and anchor examples for the respective categories for coding, (3) relating concrete text passages to the categories (with each text passage related to the categories on two dimensions, the temporal dimension (DOI theory) and the activity dimension (activity theory), (4) revisiting coding rules after 25% of the material, and (5) coding the remaining transcripts. Important to note is that latent as opposed to semantic analysis for coding [582] was used, which means that the context of the discussion and the underlying assumptions of the semantic data [582] were included in order to determine e.g. whether a text passage related to the decision to use the system or the experiences during use.

[549]: Mayring (2014)

[214]: Rogers (2003)

[290]: Engeström (2015)

[582]: Braun *et al.* (2006)

Table 10.2: Overview of focus group participants.

| No. | Gender | Age | Role | Job description | Motivation for sustainable behavior | Use of the green IS | Company |
|---|---|---|---|---|---|---|---|
| P1 | Man | 37 | Follower | Health-safety-environment coordinator | Feeling that you are doing something good | Multiple times per week, but decreasing | Company A |
| P2 | Woman | 32 | Follower | Software development | Contributing to a healthy environment in the future | Very irregularly | Company A |
| P3 | Man | 30 | Follower | Marketing | Not caring for the environment has a negative impact on ourselves | Rarely | Company A |
| P4 | Man | 39 | Manager | Customer support | Leaving future generations a planet worth living on | Daily, but decreasing | Company B |
| P5 | Woman | 38 | Follower | Customer service | Leaving a healthy world for her own children | Daily, but decreasing | Company B |
| P6 | Woman | 33 | Manager | Commercial office work | A lot can be achieved if everyone joins in | Daily, but decreasing | Company B |
| P7 | Man | 37 | Manager | Executive board sales & organization | Not destroying the future for his own children | Daily, but decreasing | Company B |
| P8 | Man | 30 | Follower | Software development | Good feeling with sustainable behavior | Multiple times per week, but decreasing | Company B |
| P9 | Man | 42 | Manager | Marketing and Business Development | The planet has suffered damage long enough and it is up to us to change something | Daily | Company C |
| P10 | Woman | 19 | Follower | Apprentice industrial clerk | Gratitude and responsible use of the luxuries we are given | Multiple times per week | Company C |
| P11 | Man | 41 | Manager | Research and Development | Current over consumption of natural resources | Daily, but decreasing | Company C |
| P12 | Male | 35 | Manager | Procurement | Competitiveness of the company | Multiple times per week | Company C |
| P13 | Woman | 32 | Follower | Marketing and Sales | Calls for people to pay attention to sustainability | Daily | Company D |
| P14 | Male | 39 | Manager | Agile coach | We hear and read that the planet goes to the dogs | Rarely | Company D |
| P15 | Woman | 30 | Follower | Product owner | Social pressure and personal interest due to effects of climate crisis | Daily | Company D |
| P16 | Man | 24 | Follower | Software development | Preventing waste of resources | Daily | Company D |
| P17 | Man | 32 | Manager | Service and support, software development | There is only one planet and there is no more time to waste | Multiple times per week | Company D |
| P18 | Man | 43 | Follower | Sales | Perspective for human civilization | Multiple times per week | Company D |

Section D.1 displays the coding guideline for the theoretical categories.

Second, for structuring of the content and for analyzing the design ideas and solutions proposed by the employees, inductive coding was used to reduce the material per identified main category, an approach similar to thematic analysis to summarize the main themes per category [549]. The inductive coding process involved (1) determining the level of selection and abstraction of themes to be coded in each main category, (2) linking deductively coded text passages either to existing themes or forming a new theme, (3) revisiting categories after 25% of the material, and (4) coding the remaining material without changing existing categories and adding new categories as needed.

[549]: Mayring (2014)

In order to test reliability of the results, an intracoder agreement check for 25% of the material was performed both in regards to the main category and the identified sub-themes [549] five months after the original coding. The intracoder agreement rate was 78,57% ($\kappa = 0.88$) for the deductive category coding and 81,82% for inductive theme coding ($\kappa = 0.94$), indicating re-test reliability of the results.

Finally, I looked at the big picture and analyzed the relationships and influences among the challenges identified in the first two steps of the analysis. In doing so, the initial findings were abstracted into five overarching themes about the challenges of adopting and using green IS in organizational contexts.

## 10.4 Results

55 different challenges that employees in the four companies noted with regard to the adoption and use of the green IS were identified, both in terms of the temporal dimension (DOI theory) and the activity dimension (activity theory), with the important exception of the dimension of division of labor, which relates to task specialization among members of a company [290]. Interestingly, in the knowledge and decision stages, challenges were mainly related to the subject, the instrument, and the rules, while in the persuasion stage, the role of the object and the community were more important. Most of the challenges were related to the implementation and confirmation stages of innovation adoption, where all activity dimensions present different challenges to be tackled. In the following, the identified challenges will be presented in detail, organized by the phases of the innovation adoption process [214]. Table 10.3 and Table 10.4 provide an overview of the detected challenges.

[290]: Engeström (2015)

[214]: Rogers (2003)

### 10.4.1 Challenges in the Knowledge Stage

Challenges that arose in the knowledge phase of the adoption and use of the green IS, i.e., related to awareness that the green IS exists and how it works, were mostly related to the **instrument**, i.e., the gamified application itself. In particular, employees referred to language barriers (P11), lack of explanation of functions through some kind of onboarding (P17), or intransparency in how certain functionalities work (P2) as barriers related to *how-to knowledge* and *principles knowledge*.

*"Here topic briefing onboarding at the beginning [...] then when I had the app again, [I didn't know] what was phase anymore because [P15] had explained it to me only once briefly" (P17).*

In addition, one participant highlighted the importance of understanding compliance with organizational privacy **rules** as a critical challenge (P7), and another referenced the challenge that **subjects** may lack technical knowledge about how to install and use any app or IS, which prevents them from even considering using it (P17). In contrast, challenges related to *awareness-knowledge* or to the object or community were not mentioned by the employees.

### 10.4.2 Challenges in the Persuasion Stage

In the persuasion stage though, where individuals form positive or negative attitudes towards the green IS [214], employees referred to challenges mainly related to the **object**, i.e., the issue of sustainability in organizational contexts [290], and the **community**.

[214]: Rogers (2003)

[290]: Engeström (2015)

In terms of the **object**, participants emphasized that sustainable behavior in the workplace was not a personal need (P1, P2, P3, P4, P5, P7). Specifically, they cited that *"you don't get anything out of it"* (P7) and that *"not to sound too mean, but it's really just about increasing sustainability in the workplace"* (P2). In addition, employees indicated that they did not see any personal consequences (P2, P5, P7, P17) or that the consequences were at least unclear (P7) if they chose not to use the green IS.

*"It is, we must say this very clearly, about the company. You don't do it for yourself, so to speak. So if a company says, okay, download this app on your private phone and now make sure you save water for me, then I can also say 'I don't give a fuck'" (P17).*

Combined with statements indicating the challenge of resistance to habit change around sustainability in the workplace (P12), it is clear that the adoption of green IS faces significant challenges due to the organizational context.

Second, given this lack of individual relevance, employees also stated that the lack of social pressure (P2, P3, P9, P10, P13, P15) and role models (P9, P12) were critical **community-related** challenges to their attitudes toward the green gamified application. In particular, they noted that use *"has to be lived. It has to be mandated, because otherwise it's useless"* (P12) and that companies might even consider making an *"obligation for them [employees] to use the app"* (P3) in order to exert social pressure on employees. In this context, P7 also stressed that from a management perspective, the cost-benefit ratio for the company to put pressure on employees to use the gamified application was not clear and that it would be important to *"using calculation examples to show companies directly why it makes sense to do it that way. [...] The part costs in sum afterwards say 1.000 €, to take a value. This equipment costs 1,000 € and you write directly behind it, so the motivation is however probably around X higher. Means your savings in CO2 that you don't have to buy as certificates,* *electricity that you don't have to pay, gas that you don't pay, water, are 5,000 €. Then it's much easier for the company to say, yeah sure, let's do it right away."* (P7).

Finally, related to the **subject** dimension, employees commented that their personal attitudes toward smartphone use (P1, P2, P4, P5, P8) played a critical role in their decision to use the gamified application.

> *"The problem is the personal attitude towards the use of apps or something like that. And if I'm not interested, then I don't do it [...]. It doesn't matter what the manager says. That's the problem. The problem or the thing, that's the personal interest" (P1).*

Also, the presence of and rivalry with other software and IS used at work (P6, P7), and the perception of the gamified application as a part of the work added to the already existing duties, hindered a positive attitude formation towards it.

> *"I think my brain saw the app as something I have to do in addition to what I already do every day during the eight or nine hours I'm here at work. And that caused me some kind of stress" (P3).*

### 10.4.3 Challenges in the Decision Stage

Challenges that occur in the decision stage are particularly revealing because they can account for the gap between attitude, intention, and action that is often observed in sustainable behavior [574].

[574]: Kollmuss *et al.* (2002)

In relation to the **subject**, employees noted that even if they had a positive attitude towards using the gamified application, they did not start using it because the system was not visible (P1, P6, P7), specifically due to the fact that the green IS was an app that was displayed on the last screen by default on smartphones.

> *"I think that was the problem, so maybe I should have kind of dragged it to the front from the beginning, because the apps that I see then in the front, I tend to think, oh, there I should be clicking something" (P6).*

Also, some employees mentioned that they kept postponing use to the future and attributed this to external circumstances (P8, P12).

> *"But then you just don't do it somehow and think to yourself, yeah, come on, the moment is bad or something and then it's already forgotten right away when you've arrived at the thought that you'll do it later or something" (P8).*

In some of the companies, there were also organizational **rules** that hindered adoption for some employees. For example, rules restricted the use of personal smartphones in the workplace (P2, P9), which prevented

**Table 10.3:** Results of data analysis categorized by the stage of innovation adoption [214] and the elements of the activity system [290] - Knowledge, Persuasion and Decision stage.

| | Knowledge | Persuasion | Decision |
|---|---|---|---|
| Subject | C1: Lack of required technical knowledge (P17) | C6: Attitude against smartphone use (P1, P2, P4, P5, P8)<br>C7: Rivalry of other software (P6, P7)<br>C8: Perception as part of work (P2, P3) | C16: Lack of system visibility (P1, P6, P7)<br>C17: Deferral of use to the future (P8, P12) |
| Instrument | C2: Language barriers (P11)<br>C3: Lack of onboarding (P17)<br>C4: Intransparencies in functionality (P2) | | |
| Object | | C9: Lack of personal need (P1, P2, P3, P4, P5, P7)<br>C10: Lack of personal consequences (P2, P5, P7, P17)<br>C11: Ambiguity of personal consequences (P7)<br>C12: Attitude against habit changes (P12) | |
| Community | | C13: Lack of social pressure (P2, P3, P9, P10, P13, P15)<br>C14: Lack of role models (P3, P9, P12)<br>C15: Cost-benefit ratio for company unclear (P7) | |
| Rules | C5: Appropriateness of data protection (P7) | | C18: Organizational regulations that impede adoption (P2, P7, P9, P10) |

employees without company phones from using the gamified application (P2) or prevented giving employees an organizational email address for authentication (P10). In addition, P7 noted that organizational rules may contradict the use of certain functions or the realization of certain instructions of the gamified application:

> *"That's an exciting question, for example, turning off the lights. I would say we are not allowed to do that. [...] Because the workplace specifications for workplaces dictate a certain amount of light. And if we turn that off, then we sit too dark" (P7).*

### 10.4.4 Challenges in the Implementation Stage

Once employees started using the gamified application, they encountered a variety of challenges related to all dimensions of the activity system [290].

[290]: Engeström (2015)

Initially, a key challenge related to the **subject** was that employees perceived the effort required to use the gamified application as too high (P1, P3, P4, P6, P7, P8, P9, P11, P14, P15, P16, P17). Often, employees could not justify why they felt the effort was too high, but some noted that it was related to *"not having the smartphone with them all the time"* (P16) to interact with the gamified application, or that it annoyed them to have to track their activities: *"It sounds a bit stupid, but the effort to enter something or whatever is somehow still too high for me in everyday life, even if it's so intuitive and quick like an app or something."* (P8). Also, employees stated that they forgot about the gamified application in everyday work (P5, P9, P10, P11, P13, P15, P16, P17, P18) and ignored triggers or reminders from the IS (P7, P8).

> *"I just didn't think about it at some point, I used it for the first 2,3,4 days and at some point I just didn't think about using it at all" (P17).*

One particular challenge that could explain why employees forgot about the gamified application in their daily work is related to the prevailing **rules** in the workplace. Participants indicated that they often saw sustainable behavior and IS use as conflicting with their work tasks (P1, P2, P3, P4, P5, P7, P16, P17). For example, focusing on using the gamified application for sustainable behavior can distract from the current task:

> *"And then I would have to change the focus and look, okay, now I have to select this, this, okay, and then do the action. That's what pulls you out. That's just the way it is with us, when it comes to development. If you're out of it for ten minutes, it takes you half an hour to get back into it" (P16).*

In some cases, this could even lead to employees deciding whether they should focus on their work tasks or on sustainable behavior (P1).

> *"Sounds nice, but I have so many things to do. What, what it's important for, for you, I can say to my manager. The manager will say, okay, then you have to do your work, not to use the app for example" (P1).*

In addition, employees referred to challenges with the rules for using gamified application (P4, P13, P15, P17, P18), which even led to a perception of unfairness (P13, P15, P18). In particular, participants mentioned ambiguities regarding the use of the gamified application in home or remote office environments (P4, P13), especially when they decided to work remotely for other reasons rather than sustainability:

> *"When am I actually allowed to mark the home office day when I do it? So I just said, hey, cool, I'm actually always here in the office, but now I've had Corona for 14 days, I had to stay at home, so I could now directly get ten times the 40 points. And then, no, you're not allowed to do that, I think, yeah, why not, I've saved on CO2. I didn't drive to work. Yes, and you weren't allowed to. So I think there's still a bit of a need for a set of rules, I have the impression" (P4).*

Notably, the lack of protection against fraud was cited by workers as a challenge that contributed to perceptions of injustice:

> *"And I have always wondered if that is also just based on trust or, you know" (P2).*

Another important challenge related to the organizational **community** mentioned by some employees, which may also lead to forgetting about the gamified application in everyday work, was the lack of interpersonal communication between colleagues (P2, P15) and interaction within the gamified application (P15).

> *"We didn't really do that very much, because one or the other was on the road a lot or was at home, so we didn't talk much about it. So hey, I did this today or I did that. Yes, that would probably have helped a little bit" (P15).*

Concerning the **object**, employees mentioned that they encountered the challenge that some tasks for sustainable behavior seemed unachievable to them, which they found demotivating: *"Well, for example, I am not a cyclist, I don't have a bicycle. Accordingly, this option is completely eliminated for me, for example, climate-friendly mobility"* (P15). Since sustainable behavior can be realized on many levels and is reflected in many actions, employees were sometimes faced with the challenge of reconstructing their behavior to track it in the gamified application:

> *"And then you look at the favorites or the actions and somehow try to reconstruct, what did I do today?" (P8).*

Finally, it must be acknowledged that challenges related to the **instrument**, particularly usability (P4, P8, P11, P17, P18), functionality (P7, P9, P11, P17), aesthetics (P2, P15, P17), structure (P3, P15), design (P7), and functionality bugs (P2) are probably mainly due to the specific design of the gamified application used in this study and are likely to occur in any IS implementation, and therefore do not present any general challenges of a green IS for sustainability in organizations. However, employees also discussed challenges related to the instrument that may be noteworthy for the context of this study. For example, they felt that the gamified application was missing triggers (P2, P4, P7, P16, P17): *"And if I'm not triggered, then it's quickly forgotten"* (P4), but at the same time mentioned that it was sometimes too intrusive (P7, P9, P11, P17). Also, employees missed a lack of company-specific individualization in terms of how employees should behave sustainably in order to feel a real connection to the gamified application: *"If you think of it as an app that should be used within [anonymized], you should also include some, let's say, [anomymized] specific knowledge"* (P2). In addition, some employees felt that the gamified application did not provide them with enough informative content related to specific topics (P2) or *"suggestions on what to do"* (P12), even though they felt that this information was a key reason for the value added by the green IS.

### 10.4.5 Challenges in the Confirmation Stage

Finally, challenges that occur during the confirmation stage are particularly important because they can determine how employees perceive their satisfaction or dissatisfaction with the green IS and reevaluate their decision to adopt it [214]. In this study, significant subject, instrument, object, and community challenges were found that prevented employees from using the gamified application in the longer term.

[214]: Rogers (2003)

Regarding the **subject**, employees mainly indicated that they lacked long-term motivation to use the gamified application (P5, P7, P8, P12) and that the cost-benefit ratio of using the application seemed insufficient for them (P7, P8, P11). Specifically, employees indicated that they lacked *"incentives"* (P12), *"connection to a long-term goal"* (P7), or concrete rewards to consider long-term use of the gamified application.

> *"It would have to be 'Let's save energy' - I don't know, 5000 kilowatt hours, I'll use that as an example. 'Then at the summer party we'll have an extra barbecue or something' [P5: Yeah, something like that]" (P7).*

However, in relation to the issue of long-term motivation, P11 also mentioned that in terms of **rules** it was very important that any incentives were appropriate to the organizational context:

> *"The prize should be something like a fruit basket, I think that's good. Anything else would be kind of inappropriate again" (P11).*

In addition, employees mentioned that there was a novelty effect in using the gamified application that initially made them want to use it, but that diminished over time: *"It's nice when you've seen it all once and then a second time. And then you want the time, I actually didn't want to spend the time there all the time anymore"* (P11). It is particularly noteworthy that P15, who indicated that sustainable living was already very important to her, also felt that her expectations of the green IS were not met, which made her dissatisfied:

> *"For me, the motivation was actually to live more sustainably and not to skim off what I'm actually doing. That's why it was a bit funny. I was in first place relatively quickly because I eat vegetarian food every day and turn off the toilet light every time I go out there and always turn off all the hallway lights anyway. That's not really the challenge, and the challenge was what was actually interesting about it" (P15).*

In terms of the **instrument**, employees saw a critical challenge in the long term as a lack of connection to the work environment (P2, P4, P5, P7, P9) and suggested that the gamified application should be supplemented with offline nudges such as *"post-its"* (P5) or *"posters"* (P5) to improve this connection to the everyday work environment. They also missed ways to individualize their interaction with the gamified application:

> *That you have a little more flexibility in actions or even other actions that you might have thought of" (P13).*

Related to the **object**, i.e., sustainability, a key challenge to long-term engagement in sustainable behavior by the gamified application was that employees did not experience their behavior and achievements as transparent (P3, P5, P8, P15) and relevant (P5, P8). In particular, they missed *"being proud of what you've accomplished"* (P8) or seeing relevance in *"how much [they] have accomplished with the company so far"* (P3).

> *"It would be cool if that was said a little bit more actively because you've saved so much water, we now have this and this or something" (P15).*

Of particular interest is that the youngest participant also observed a decreasing relevance of sustainability as a topic over time, making long-term engagement more difficult:

> *"But I would say that the trend, I think sustainability is a huge trend, [...] And I think that's also a trend where you say, yeah every trend, after a while it has that here again, that it goes down" (P10).*

Finally, employees cited key **community** challenges that prevented long-term use of the gamified application for them. Among other things, a critical mass of users needs to be reached so that the overall commitment to sustainability in the workplace is perceived as valuable (P2, P3, P4, P6).

> *"But I think if more people participated, then, yeah, you would be more likely to stick with it" (P6).*

P3, in particular, expressed how frustrating it was to use the gamified application but to feel like he was alone in his commitment:

> *"But if I feel like I'm the only one or that we're really few, then you say, okay, that's kind of like, I'm not running with the others. We're not all rowing in the same direction. I'm the only one rowing in that direction and the others just aren't as active" (P3).*

Employees also mentioned that they found it significantly demotivating when they observed diminishing use by their colleagues (P6, P7):

> *"And for me personally, the motivation has decreased because we have used less and also set fewer goals together or created challenges. That group dynamic [...] as soon as the group stops or the tendency decreases, in terms of usage, it almost completely drops off" (P7).*

**Table 10.4:** Results of data analysis categorized by the stage of innovation adoption [214] and the elements of the activity system [290] - Implementation and Confirmation stage.

| | Implementation | Confirmation |
|---|---|---|
| Subject | C19: Effort too high (P1, P3, P4, P6, P7, P8, P9, P11, P14, P15, P16, P17)<br>C20: Forgotten in everyday work (P5, P9, P10, P11, P13, P15, P16, P17, P18)<br>C21: Ignorance of triggers and reminders (P7, P8)<br>C22: Perception as unmotivating (P18)<br>C23: Experience of failure (P18) | C42: Lack of long-term motivation (P5, P7, P8, P12)<br>C43: Cost-benefit ratio insufficient (P7, P8, P11)<br>C44: Decrease in novelty (P7, P11)<br>C45: Unfulfilled expectations (P15) |
| Instrument | C24: Obstacles in usability (P4, P8, P11, P17, P18)<br>C25: Lack of trigger to continue use (P2, P4, P7, P16, P17)<br>C26: Intrusive features (P7, P9, P11, P17)<br>C27: Aesthetics do not meet personal taste (P2, P15, P17)<br>C28: Lack of company-specific individualization (P2, P9, P12)<br>C29: Lack of informational content (P2, P12)<br>C30: Lack of structure (P3, P15)<br>C31: Complicated design (P7)<br>C32: Bugs in functionality (P2) | C46: Lack of connection to work environment (P2, P4, P5, P7, P9)<br>C47: Lack of individualization (P8, P13) |
| Object | C33: Unfulfillability of tasks (P2, P15, P18)<br>C34: Difficulty of reconstruction (P8, P18) | C48: Lack of transparency of achievements (P3, P5, P8, P15)<br>C49: Lack of relevance of achievements (P5, P8)<br>C50: Decreasing topic relevance (P10)<br>C51: Inappropriate difficulty (P17) |
| Community | C35: Lack of interpersonal communication (P2, P15)<br>C36: Lack of interaction (P15) | C52: Critical mass of users (P1, P2, P3, P4, P6)<br>C53: Decreasing use by colleagues (P6, P7)<br>C54: Lack of celebration of team achievements (P4, P9) |
| Rules | C37: Conflict with work tasks (P1, P2, P3, P4, P5, P7, P16, P17)<br>C38: Lack of clear rules (P4, P13, P15, P17,P18)<br>C39: Perception of imbalance and unfairness (P13, P15, P18)<br>C40: Lack of control and fraud protection (P2, P11)<br>C41: Excessive rules (P7) | C55: Appropriateness of incentives (P11) |

### 10.4.6 Overarching Themes

The exploratory analysis revealed several challenges that employees face in adopting and using green IS in the workplace. Carefully considering the interactions between the different challenges of the activity system dimensions over time, five overarching themes that *interrelate different activity dimensions and stages of innovation adoption* and may hinder

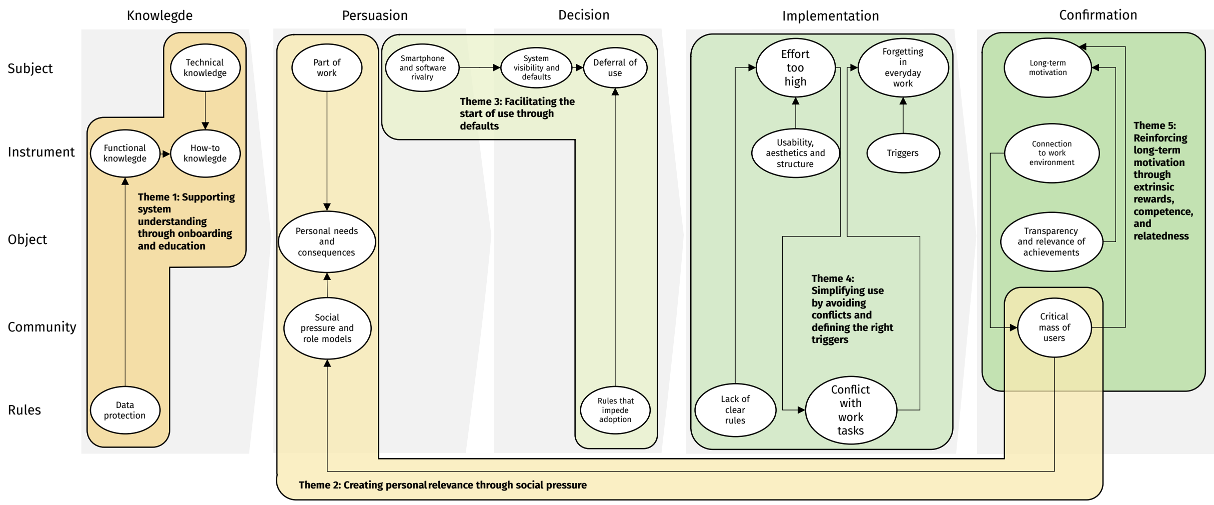


Figure 10.4: Five overarching themes of challenges that hinder the adoption and use of green IS in organizational contexts.

the adoption of green IS in organizational contexts can be identified (see Figure 10.4 for an overview).

**Theme 1: Supporting system understanding through onboarding and education.** Although few of the challenges cited by employees related to the knowledge phase of innovation adoption, challenges related to functional knowledge (e.g., opaqueness in functionality and uncertainties about the adequacy of data protection) and how-to knowledge (e.g., lack of onboarding and technical knowledge about how to use a smartphone application) can hinder further adoption of green IS, while awareness knowledge was not cited as a particular problem. The overarching theme in the knowledge phase is therefore to educate employees about the operating principles of the green IS, take into account their individual technical knowledge backgrounds, and respect data security clarification so that employees feel safe and secure interacting with the green IS.

**Theme 2: Creating personal relevance through social pressure.** The workplace context poses a particular challenge when it comes to the personal need and consequences of sustainable behavior in the persuasion stage - employees receive no direct personal benefit (such as lower costs from saving energy at home) and therefore hesitate to behave sustainably for the sake of supporting their employer. Further, the fact that they perceive the green IS as part of the job, and thus as an add-on to the duties they already have, makes it even less personally relevant. However, employees emphasized the role of the community, especially social pressure and role models in the company. In particular, the absence of hierarchical or team pressure to use green IS lowers relevance, whereas "living sustainability" as part of the team culture and more stringent pressures such as obligations to use green IS exert social pressure that can lead to personal consequences not provided by the topic alone. The overarching theme in the persuasion phase is therefore to create personal relevance for individual employees through social pressure mechanisms and role models within the community so that employees feel a social relevance for using the green IS even without a direct personal need or benefit.

**Theme 3: Facilitating the start of use through defaults.** The biggest challenges mentioned by employees in the decision stage relate to the deferral of use. A lack of visibility of the system, which is also influenced by the format of the smartphone app (e.g., because the green IS as an app defaults to the last smartphone page and competes with other apps and IS used in the workplace), as well as organizational rules (such as a restriction on smartphone use during working hours or a lack of authentication options), were reported to prevent a direct start of the use of the green IS and invoke delays in green IS adoption. Therefore, the main challenge in the decision stage is to find design solutions to combat such postponement and facilitate the start of use by setting the right defaults - both in terms of visibility (where to place the green IS on target devices or how to best link it to the existing IS in the workplace) and in terms of rules (considering authentication and usage processes upfront and defining a format that every employee can easily use).

Theme 4: Simplifying use by avoiding conflicts and defining the right triggers. Employees identified three main and interrelated challenges during the implementation phase: the effort was too high, they experienced conflict with work tasks, and they forgot about the green IS in their daily work routine. Challenges related to the lack of clear rules for using the green IS (e.g., when to use it and when not to use it) and obstacles related to the instrument itself in terms of usability, aesthetics, and structure mainly contribute to the perception of effort, which in turn could increase the perceived conflict between using the green IS and work tasks. Apparently, employees prioritized their work tasks over the green IS, so after the first few days they forgot about the green IS in their daily work routine. The challenge that the instrument did not sufficiently trigger employees to use it probably contributed further. Thus, the design and rule system of the green IS can create a critical conflict between work and sustainability in the organizational context. The overarching theme in the implementation phase is therefore primarily to simplify use by considering and avoiding potential conflicts in advance, so that employees do not perceive sustainable behavior as competing with their work tasks.

Theme 5: Reinforcing long-term motivation through extrinsic rewards, competence, and relatedness. Employees cited a lack of long-term motivation to use the green IS as the biggest challenge in the confirmation phase. On the one hand, this referred to the lack of extrinsic rewards or other extrinsic benefits for continued use of the green IS, a critical finding that demonstrates the importance of extrinsic motivation in the work environment. On the other hand, employees did not see the transparency and relevance of their achievements in sustainable behavior (e.g., the impact of what they accomplished toward a long-term goal). Finally, the lack of a critical mass of users prevents the experience of a community commitment to sustainability, which contributes to diminishing long-term motivation. Exacerbating the above is the fact that the green IS was not sufficiently connected to the offline work environment, which may have led to declining use by colleagues. Since not all employees are at the same stage of technology adoption at the same time, the circumstance that only a minority of colleagues are using the green IS for sustainability in the workplace reduces social pressure and lacks role models for additional users. The key overarching theme in the confirmation phase is therefore to reinforce long-term motivation by promoting extrinsic and intrinsic motivation through incentives and by meeting employees' needs for competence and relatedness in sustainable behavior at work.

### 10.4.7 Design Suggestions

Participants cited 44 different design suggestions that could help overcome the above challenges to sustainable employee behavior at work. Most of these design suggestions related to the instrument, i.e., the gamified application itself, in the implementation stage as ways to simplify its use and define the right triggers (Theme 4). In addition, employees mentioned a variety of design suggestions within and outside the application that could help create personal relevance through social pressure (Theme 2) and strengthen long-term motivation (Theme 5). Notably, participants did not offer any suggestions regarding the decision stage or facilitating the start of use through defaults (Theme 3). Table 10.5 and Table 10.6 show the results of the inductive analysis.

In terms of supporting system understanding (Theme 1) in the knowledge stage, employees mentioned that informational materials and posters outside the app (P5, P9, P13) and an onboarding tour with the avatar Leafy could help raise awareness-knowledge and how-to knowledge to use the gamified application.

> *"Make sure that somehow posters hang everywhere here to encourage the use if we get a portal message and maybe another mail. That's not gonna have any effect. You'll definitely have a bigger impact if you somehow have a poster hanging in every team kitchen or something like that" (P5).*

In terms of creating personal relevance through social pressure (Theme 2) in the persuasion stage, employees mentioned that company-wide (P3, P7, P9, P11) or team goals set by the company (P7, P9, P12), also in combination with incentives (P16), could help build social pressure on others to participate and contribute to these goals.

> *"If you have a few colleagues with you who maybe don't want to do the stuff or refuse to participate, then you say, 'Listen, there's not much left, help out, join in a bit and then [P16: then we'll get a pool.]' Yes, exactly" (P13).*

To showcase role models and emphasize the relevance of participation, team accomplishments should be visualized outside the app (P5, P7), and features such as *"profiles from other people"* (P17) or *"a timeline with all the actions taken"* (P3) could help build vicarious experiences, i.e., seeing what others have achieved and how they did it, as a starting point for building self-efficacy [352] and promoting individual relevance.

[352]: Bandura (1982)

> *"Then you say, okay, I will take this action as well. Maybe tomorrow I will think on doing this as well in order to reduce it" (P3).*

In the context of defining the right triggers (Theme 4), employees suggested a variety of different notifications that the gamified app could include as part of a comprehensive trigger system, such as general or "intelligent" reminders for specific actions, notifications about events in the app, and motivational messages. In particular, some employees also wanted these

Table 10.5: Design suggestions noted by the participants to overcome the identified challenges - Theme 1-4.

| Related theme | Design suggestion to overcome challenges | Participants | Related challenges |
|---|---|---|---|
| Theme 1: Supporting system understanding through onboarding and education | Information materials and posters outside the app | P5, P9, P13 | C3, C4, C46 |
| | Onboarding tour with Leafy | P17 | C3 |
| Theme 2: Creating personal relevance through social pressure. | Company-wide goals set by company | P3, P7, P9, P11, P16 | C9, C13 |
| | Milestones and team goalsP7, P9, P12 | C9, C13 | |
| | Visualizations of team achievements outside the app (e.g. on monitors) | P5, P7 | C14, C46 |
| | Show how others gathered points | P9, P10 | C14, C49 |
| | See others' profiles | P17 | C14 |
| | Timeline with actions taken by colleagues | P3 | C14, C49 |
| Theme 4: Simplifying use by avoiding conflicts and defining the right triggers. | General reminders for specific actions | P5, P7, P10, P11, P12, P15, P18 | C20, C25 |
| | Intelligent reminders for specific actions | P4, P7, P12, P14, P16, P17 | C20, C25 |
| | Individualization in reminder settings | P4, P5, P10, P11, P12 | C21 |
| | Notifications from events in the app | P4, P9, P11, P12, P15 | C20, C25 |
| | Motivational messages as notifications | P1, P9, P10 | C25 |
| | Automation of actions (e.g. recurring actions) | P4, P12, P16, P18 | C19 |
| | QR-codes for performing actions outside the app | P9, P14, P17 | C19 |
| | Perform actions in action suggestions screen | P4, P5, P18 | C19, C24 |
| | Add easier way to perform actions (e.g. widget) | P7, P8, P16 | C19, C24 |
| | Perform the same action multiple times at once | P4, P9 | C19, C24 |
| | Add specific actions for company | P2, P9, P12 | C28 |
| | Add rules to restrict actions | P2, P13 | C38 |
| | More animations | P3, P9 | C27 |
| | Restructure action descriptions | P3, P15 | C27 |
| | Opportunity to rewind action performance | P15 | C24 |
| | Deselect actions by swiping down | P17 | C24 |
| | Show animation only once after multiple actions | P11 | C26 |
| | Implement other mechanic for favorizing actions | P8 | C24 |
| | Unread messages badge | P7 | C25 |
| | Prove at least 3 actions with photos | P3 | C40 |
| | Improve contrasts and UX design | P17 | C27 |
| | Balance action points | P18 | C39 |
| | Faster animations | P17 | C26 |
| | Specify actions | P14 | C38 |
| | Sort favorite actions by color | P15 | C27 |
| | Add dark mode | P17 | C27 |

reminders to be individualized so that the application would not be perceived as intrusive (P4, P5, P10, P11, P12).

> *"You can set that, maybe [P5: yeah exactly], that one says, like, how many reminders do I actually want? I don't know. Slider five levels, like, piss me off all the time, I want to save the world [everyone laughs] or, leave me alone, I'll go along with it if I have to, but I honestly don't care" (P4).*

On the other hand, employees named several design suggestions to simplify use (Theme 4). In particular, performing sustainability actions should be made more effortless, e.g., through automation (P4, P12, P16, P18), using QR codes outside the app (P9, P14, P17) or widgets (P7, P8, P16), and allowing multiple actions to be performed at the same time (P4, P9).

> *"I have for example for my front door, lock door open. I do not want to go into the front door app, select the door lock (..) that sucks, but, I go into my widget, zap door open, all the important stuff is in there. That could help, for example, shorten this, the distance to the action performed" (P7).*

To reduce ambiguity in the rules, actions should be restricted, e.g., based on date or time (P2, P13), and explained in more detail (P14), and to avoid errors, actions should be reversible (P15). In addition, two participants pointed out possible improvements in interface design to enhance usability and aesthetic experience from their perspective, e.g., faster animations (P17), higher contrasts (P17), sorting favorite actions by color (P15), and adding a dark mode (P17).

Finally, regarding long-term motivation (Theme 5), most participants voted for material incentives as extrinsic rewards to create long-term motivation and added several suggestions for possible suitable incentives, such as fruit baskets (P9, P10), planting trees (P2, P3), team events (P4, P7, P9), or vouchers (P7, P16).

> *"When incentives are there. Then you keep doing it. I think it's as simple as that" (P12).*

In addition, participants mentioned that badges (P3, P4, P8, P9, P15, P17) and a history of actions taken (P4, P8, P15) could help visualize one's sustainability achievements. Personal recognition by the company (P3), competitions between company sites (P17), the possibility to congratulate others (P15) or the possibility to redeem points in the application, e.g. by upgrading the avatar Leafy (P13), could help to increase the relevance of these achievements, both from a competence- and a relatedness-oriented perspective.

> *"Hey, you're super sustainable, really cool here, high five digital, not in real life, because we have Corona" (P15).*

In addition, employees desired constant new content (P5, P12) to counteract the decline of novelty and individual lifestyle settings (P2, P16), or the ability

Table 10.6: Design suggestions noted by the participants to overcome the identified challenges - Theme 5.

| Related theme | Design suggestion to overcome challenges | Participants | Related challenges |
|---|---|---|---|
| Theme 5: Reinforcing long-term motivation through extrinsic rewards, competence, and relatedness. | Material incentives (plant trees, money for team event, vouchers,...) | P2, P3, P4, P5, P7, P9, P10, P12, P13, P16, P17, P18 | C42, C43, C55 |
| | Profile with badges | P3, P4, P8, P9, P15, P17 | C48 |
| | History of performed actions | P4, P8, P15 | C34, C48 |
| | Continuous new content | P5, P12 | C44 |
| | Individual settings about lifestyle | P2, P16 | C47 |
| | Personal acknowledgments from company outside the app | P3 | C49 |
| | Competitions between company sites | P17 | C46, C54 |
| | Congratulate others | P15 | C49 |
| | Upgrade Leafy with earned points | P16 | C49 |
| | Early adopter badge | P7 | C48 |
| | Action suggestions from user side | P13 | C47 |

to suggest actions (P13) to improve the "personal fit" with the gamified application.

In summary, the identification of the five overarching themes in the adoption and use of green IS in the workplace on the example of the developed gamified app contributes both to the theoretical understanding and discussion of the adoption of green IS in organizations and, along with insights into employee perspectives on potential design solutions, to the derivation of practical implications for organizations on how to design and implement IS for their employees.

## 10.5 Discussion

Research has called for a greater focus on user perceptions and individual perspectives on the adoption and use of green IS in organizational settings [40], [213], considering the specifics of the sustainability context during the adoption process [195]. This study provides deep insights into the hitherto unexplored challenges of adopting and using green IS from the employee perspective, taking into account the individual cognitive processes of adoption and the tensions that arise between the organizational context and the issue of sustainability. In doing so, this work addresses critical shortcomings of previous work on the adoption of sustainability IS in organizational environments, which has focused primarily on technology adoption factors (e.g. [197], [198], [200], [206]) from an organizational, economic, or regulatory perspective [40].

[40]: Singh *et al.* (2020)
[213]: Marikyan *et al.* (2019)

[195]: Papagiannidis *et al.* (2022)

[197]: Mulcahy *et al.* (2019)
[198]: Wunderlich *et al.* (2019)
[200]: Brooks *et al.* (2018)
[206]: Dalvi-Esfahani *et al.* (2019)

The hybrid approach of theoretical-deductive and inductive interpretive phases led to the identification of five overarching themes of challenges that hinder the adoption and use of green IS in organizational contexts: (1) supporting system understanding through onboarding and education, (2) creating personal relevance through social pressure, (3) facilitating the start of use through defaults, (4) simplifying use by avoiding conflicts

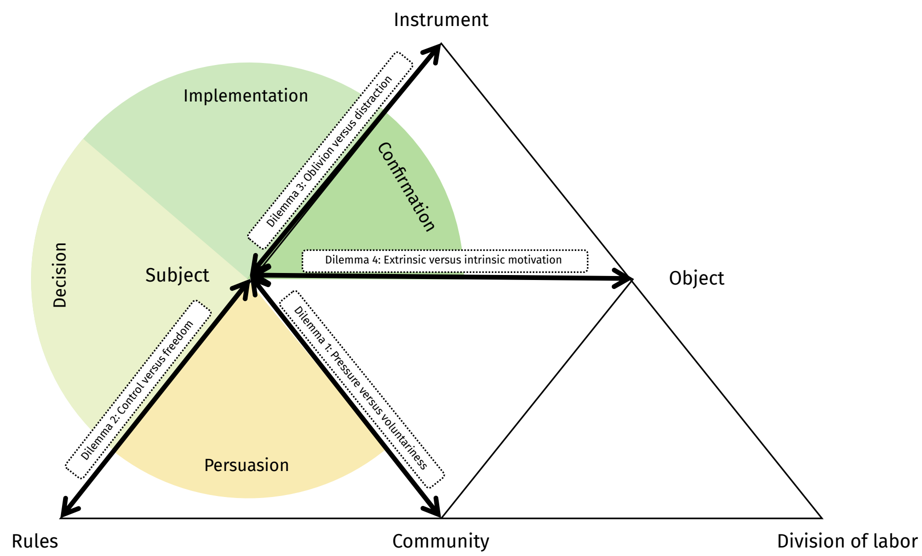


Figure 10.5: Theoretical model of dilemmas in the adoption and use of green IS in organizational contexts in light of motivational design.

and defining the rights triggers, and (5) reinforcing long-term motivation through extrinsic rewards, competence, and relatedness.

These themes might be overcome by design solutions such as (1) appropriate informational materials outside the app and detailed onboarding, (2) company-wide and team goals, visualizations of team accomplishments, and the ability to see what colleagues are contributing, (4) a comprehensive reminder and notification system, automation and widgets, and smooth user interface design, and (5) material incentives, badges and action histories, continuous new content, and reciprocal praise.

To draw implications from these findings for the future design of the gamified app in the next DSR cycle and the general design of green IS in further research and practice, there is merit in discussing the findings in light of research on motivational design, which aims to support utilitarian outcomes of IS through positive affective and social experiences [46], [48], [583].

[46]: Hassan *et al.* (2019)
[48]: Koivisto *et al.* (2019)
[583]: Koo *et al.* (2015)

In critically juxtaposing the themes of challenges and design suggestions with motivational design theory, it becomes evident that overcoming these challenges, and thus enabling employees to smoothly adopt green IS through the implementation of motivational affordances, is not straightforward. Rather, these challenges cause dilemmas in the design and implementation of green IS in organizations that spur higher-level, transversal discussions about green IS design and implementation. These dilemmas result from critical tensions between the subject (the employee) and the community (the colleagues), the rules, the instrument (the green IS) and the object (sustainable behavior), which occur at different stages of the individual adoption process of green IS. Figure 10.5 illustrates the theoretical model of dilemmas in the adoption and use of green IS in organizational contexts in light of motivational design, which will be discussed in more detail hereafter.

**Dilemma 1: Pressure versus voluntariness.** As already explained, green IS that aim to motivate and encourage sustainable employee behavior often use motivational features such as feedback and progression [41], [43], as

[41]: Casado-Mansilla *et al.* (2020)
[43]: Spence *et al.* (2018)

well as gamification in the form of leaderboards, points, badges, [47] or narratives [84] to enhance the hedonic experience of sustainable behavior. Because user experiences cannot be coerced, motivational design of IS is particularly relevant in contexts where the use of IS is considered voluntary [584]. However, Theme 2 (creating personal relevance through social pressure) raises the question of whether encouraging voluntary engagement through motivational design is sufficient to promote the adoption of green IS in organizations. The results of this study show that in the persuasion stage, the relevance of using green IS (and the consequences of not using green IS) depends on social pressure from colleagues and the organization, sometimes even in the form of coercion, as employees seem to lack a personal need or benefit of sustainable behavior in the organizational setting. Evidence from IS research is inconclusive as to whether voluntariness is not a critical factor for IS adoption [585] or whether such social pressure mechanisms that limit voluntariness of participation can critically backfire [586] because forced behavior can cause individuals to become indifferent to it [587]. Thus, further research is needed on the dilemma of voluntariness versus social pressure and coercion and its implications for the design and use of green IS in organizational contexts.

[47]: Hillebrand *et al.* (2021)
[84]: Oppong-Tawiah *et al.* (2020)
[584]: Wu *et al.* (2009)
[585]: Jeyaraj (2021)
[586]: Tsai *et al.* (2017)
[587]: Saeed *et al.* (2013)

**Dilemma 2: Control versus freedom.** Theme 3 (facilitating the start of use through defaults) and Theme 4 (simplifying use by avoiding conflicts and defining the right triggers) suggest that an integrated rule system with rules that provide defaults and guidelines on where, when, and how to use green IS in the organizational setting can facilitate the onset of use and reduce the cognitive effort required for employees to use green IS in the decision and implementation phases of individual green IS adoption. However, this rule-based and structured design, commonly referred to as *ludus* in motivational design theory, is at odds with free and unstructured playful experiences (*paidia*) [228], [249], [511]. Overly structuring and constraining the system experience may come at the expense of creative action and thinking, and ultimately compromise the intended outcomes of motivational design in organizational contexts [48]. Similarly, control and protection against cheating to effectively combat fraud and unfairness in green IS may come at the expense of privacy and imply constant surveillance, opening up ethical discussions about motivational design in green IS [588]. Studies show that requiring self-disclosure inhibits the motivational effects of green IS [187] and that privacy concerns can critically inhibit green IS adoption [197]. Other work suggests that mutual surveillance between familiar individuals in green IS can increase sustainable behavior, at least in collectivist cultures [589]. This indicates that research on how to resolve the dilemma between control and freedom in the adoption and use of green IS in organizational contexts through green IS design is still in its infancy and merits further investigation.

[228]: Caillois (1961)
[249]: Hamari *et al.* (2015)
[511]: Deterding (2015)
[48]: Koivisto *et al.* (2019)
[588]: Lilley *et al.* (2013)
[187]: Shevchuk *et al.* (2019)
[197]: Mulcahy *et al.* (2019)
[589]: Kimura *et al.* (2011)

**Dilemma 3: Oblivion versus distraction.** The conflict perceived by employees between sustainable behavior and work duties poses a dilemma for the design and perception of the green IS in the implementation phase (Theme 4: simplifying use by avoiding conflicts and defining the right triggers). Previous studies postulate that immediate feedback [28], [92], [590] and recurring triggers [41], [591] both inside and outside the IS are valuable motivational prompts to increase interaction with the IS and thus counteract forgetting in the workday, an observation that is particularly reflected in the design suggestions of employees. However, the findings also question whether more interaction with the green IS is better in organizational con-

[28]: Khosrowpour *et al.* (2018)
[92]: Loock *et al.* (2011)
[590]: Castelli *et al.* (2015)
[41]: Casado-Mansilla *et al.* (2020)
[591]: Langrial *et al.* (2014)

texts. Motivational design and features can also be perceived as intrusive [592] and distracting from work [593], the latter critically interfering with expectations of job duties placed on employees in organizational settings. In a sense, motivational design of green IS in the organizational environment seems to be a balancing act of either being perceived as intrusive or being forgotten, and further research is needed to investigate different green IS designs to find the sweet spot.

[592]: Mani *et al.* (2017)

[593]: Yoon *et al.* (2021)

**Dilemma 4: Extrinsic versus intrinsic motivation.** Both research on sustainable behavior [594] and motivational design [367] have pointed out the pitfall that extrinsic incentives can undermine intrinsic motivation for sustainable behavior once the incentives are no longer present, or even lead to counter-effects [13]. However, Theme 5 (reinforcing long-term motivation through extrinsic rewards, competence, and relatedness) and the emphasis that employees place on material incentives suggest that extrinsic incentives and social pressure are key to creating long-term motivation for using green IS and sustainable behaviors in the confirmation stage of individual adoption of green IS. In particular, the findings of this study raise the question of whether the motivational design of green IS is sufficient to promote intrinsic motivation in the absence of personal needs and the benefits of sustainability as an overarching objective. In contrast to potential motivational pitfalls, studies have also observed positive effects of extrinsic motivation on sustainable behavior [595] and adoption of green IS [583], particularly in organizational settings [596]. On the basis of this discussion of extrinsic and intrinsic motivation for green IS design, there may be a trade-off in reaching the critical mass of users to exert sufficient social pressure on all employees through extrinsic incentives, at the expense of intrinsic motivation for those employees who are already interested or voluntarily want to learn more about sustainability. There is merit in further research to explore the role of extrinsic and intrinsic motivation in the particular context of sustainability in organizations and how green IS design can be realized to find a beneficial consensus.

[594]: Iweka *et al.* (2019)

[367]: Deci *et al.* (1999)

[13]: Delmas *et al.* (2013)

[595]: Lossin *et al.* (2016)

[583]: Koo *et al.* (2015)

[596]: Handgraaf *et al.* (2013)

From the discussion of the results in light of motivational design theory, it can be seen that the challenges that hinder the adoption and use of green IS in organizational settings involve four critical dilemmas for green IS design that result from tensions between the subject and the community, rules, the instrument and the object at different stages of the individual adoption process of green IS. Thus, the findings underscore that simply considering a set of fulfilled factors for the adoption of green IS and opting for motivational affordances in green IS design does *not* automatically lead to their adoption, use, continued use, and positive sustainability outcomes. Instead, the challenges, overarching themes, design suggestions and dilemmas identified provide valuable contributions to further theoretical research and suggest that the practical design of green IS should consider these challenges and contradictions thoughtfully to ensure successful implementation of green IS in organizations.

## 10.6 Implications

### 10.6.1 Implications for Theory

The results of this work contribute to expanding existing knowledge in the fields of (1) adoption and use of green IS, (2) design of green IS and general motivational design of IS in an organizational context, and (3) sustainable behavior interventions in organizations at a general level.

(1) First, given the identified challenges and dilemmas arising from the tension between the topic of sustainability and the organizational context, the findings critically question the dominance of the research focus on organizational, economic, and regulatory factors of technology adoption in research on green IS adoption [40], [195] and underscore the need for a shift in focus to consider individual perspectives on green IS adoption, taking into account individual cognitive processes [213], [40]. Through an in-depth qualitative study of employees' perceptions at different stages of technology adoption, this study shows that limiting green IS adoption to the fulfillment of predefined acceptance factors from technology adoption models cannot account for the conflicts that arise in the adoption process. Positivist models, for example, posit that attitudes toward green IS (formed in the persuasion phase) influence behavioral intention to use green IS (formed in the decision phase, e.g., [202], [203]) and explain actual use (in the implementation phase) of green IS (e.g., [203], [196]). However, simply testing models limits the development of new theories that explain how and why adoption factors lead — or, in the case of the critical dilemmas identified, do not lead — to adoption and long-term use of green IS. Rather, the approach of conceptualizing green IS adoption based on DOI theory and activity theory to develop a new understanding of green IS adoption challenges has proven to be a valuable means of advancing green IS theory by drawing on insights from innovation and behavioral research. Green IS studies are therefore invited to look beyond theories of technology adoption and explore how theories and knowledge from related or even completely distinct fields can reshape our perspective and thereby enhance our understanding of green IS adoption. The theoretically grounded model of the four dilemmas in the adoption and use of green IS in organizational contexts provides a valuable new starting point for further exploration of the tensions between sustainability and the organizational environment. Because the subject is at the center of the tensions in the adoption process, future research should examine the role of these dilemmas, taking into account the subject's personality [597], goal orientations [598], and other dispositions that may influence the employee's perception of these tensions. In addition, further research is invited that uses these findings as a basis to examine how different contexts (beyond the organizational context) influence these dilemmas and to extend the current model to include other dilemmas that may occur in different contexts. For example, in private households, there may be additional tensions for individuals arising from the division of labor among family members that influence the ways in which green IS may or may not be adopted and used for sustainable behaviors at home.

(2) Second, the findings contribute to discussions about the design of green IS in particular and the general motivational design of IS in organizational contexts. As the dilemmas show, there are critical tensions around whether green IS design should be guided by strict rules as opposed to allowing creative play [48] and the extent to which control and fraud protection are worth limiting individual privacy [187], [197], [589]. Moreover, green IS design faces the challenge of balancing the provision of essential triggers for interaction [41], [591] with distraction from work [593]. These tensions are not unique to green IS design, but rather represent dilemmas that arise for motivational IS design in organizational contexts in general whenever

[40]: Singh *et al.* (2020)
[195]: Papagiannidis *et al.* (2022)
[213]: Marikyan *et al.* (2019)
[202]: Wati *et al.* (2012)
[203]: Herrenkind *et al.* (2019)
[196]: Wunderlich *et al.* (2012)
[597]: McCrae *et al.* (1992)
[598]: Pintrich (2000)
[48]: Koivisto *et al.* (2019)
[187]: Shevchuk *et al.* (2019)
[197]: Mulcahy *et al.* (2019)
[589]: Kimura *et al.* (2011)
[41]: Casado-Mansilla *et al.* (2020)
[591]: Langrial *et al.* (2014)
[593]: Yoon *et al.* (2021)

an issue such as sustainability, compliance, IT security, or health is added to employees' daily work tasks. In line with the call for more design-oriented IS research [90], [599], future research is invited to build on these dilemmas and explore how different motivational designs can help solve these dilemmas in organizational contexts.

[90]: Lehnhoff *et al.* (2021)
[599]: Ågerfalk *et al.* (2022)

(3) Third, the findings hold implications for research on sustainable employee behavior interventions beyond green IS. Through identification of the dilemmas, light is shed on the reasons why the intention-behavior gap commonly occurs in sustainable behavior and also in sustainability interventions. On the one hand, the question of whether sustainability interventions should be considered voluntary or mandatory in an organizational context is raised. While previous work on the role of voluntariness in IS adoption is inconclusive [585]–[587], there is a dearth of research examining the role of voluntariness in behavior change interventions in the sustainability context-a topic that urgently deserves further attention. In particular, the findings of this study encourage further investigation into how social pressures or hierarchical obligations influence the experiences and outcomes of interventions for sustainable behavior in organizations. In addition, the results contribute to the discussion on the role of extrinsic and intrinsic motivation in sustainable behavior change interventions. While research has argued both against [13], [367], [594] and in favor [583], [595], [596] of extrinsic incentives in behavior change interventions, the results of this work suggest that despite the potential motivational pitfalls of extrinsic rewards for already interested and intrinsically motivated employees, intrinsic motivational designs are not sufficient to promote long-term motivation for others. Instead, the relevance of extrinsic incentives and social pressure to attract the relevant critical mass of users who lack individual relevance and need to engage in sustainable behaviors in the organizational environment is emphasized. Further and more experimental research is needed to examine how extrinsic and intrinsic motivations unfold in the participation and effects of sustainable behavior change interventions in organizational contexts.

[585]: Jeyaraj (2021)
[586]: Tsai *et al.* (2017)
[587]: Saeed *et al.* (2013)

[13]: Delmas *et al.* (2013)
[367]: Deci *et al.* (1999)
[594]: Iweka *et al.* (2019)

[583]: Koo *et al.* (2015)
[595]: Lossin *et al.* (2016)
[596]: Handgraaf *et al.* (2013)

### 10.6.2 Implications for Practice

The exploration of the challenges, design suggestions and dilemmas of implementing green IS in organizations not only opens up valuable avenues for future theoretical endeavors, but also provides practical implications for the design and implementation of green IS in organizations.

First, the findings critically suggest that organizations seeking to educate and motivate employees to adopt sustainable behaviors through green IS should place these employees at the center of the green IS development process. The results highlight that organizational and economic perspectives alone are not sufficient to understand employee perceptions and their adoption process. Rather, companies should implement participatory design processes in which employees become co-creators of the intended intervention [599], [600], to include their needs and expectations from the beginning and to increase perceived relevance of the topic of sustainability through ownership, even if their suggestions, as elaborated in Chapter 8, should always be taken with a grain of salt.

[600]: Cherry *et al.* (1999)

Second, the findings highlight that critical dilemmas between the subject and the community, the rules, the instrument, and the object arise from challenges and tensions peculiar to the specific context of sustainability in organizations. Most importantly, employees do not feel an inherent need to engage in sustainable behaviors and may perceive that sustainable behaviors interfere with work tasks. Organizations should focus on training their leaders to recognize the strategic importance of sustainability, place it on a similar level as work tasks, and serve as role models for their employees. Sustainability leaders play a central role in increasing the relevance of sustainable behavior in the organization and ultimately unleashing the potential of green IS for sustainable business transformation [601].

[601]: Liao (2022)

Finally, the findings underscore the importance of considering how green IS are embedded in the larger organizational environment. The identified challenges suggest that great green IS design alone may not be sufficient to trigger long-term behavior change among employees. For example, "offline" feedback mechanisms and triggers that raise awareness of the importance of continuous sustainable behavior outside the boundaries of green IS [41] represent a valuable design opportunity that may not collide with work tasks as much as system reminders. In addition, despite potential risks, organizations should consider how to align green IS implementation with extrinsic motivational campaigns [595], [596] that incentivize sustainable behavior to encourage a critical mass of employees to participate, initiating social movements and cultural change toward sustainability within the organization [602].

[41]: Casado-Mansilla *et al.* (2020)

[595]: Lossin *et al.* (2016)
[596]: Handgraaf *et al.* (2013)

[602]: Henkel *et al.* (2017)

## 10.7 Conclusion and Limitations

In response to urgent calls to shift the focus of research on green IS from simply examining adoption factors from organizational and economic perspectives to considering individual perspectives in the adoption process, this study focused on examining individual challenges encountered in the process of adopting and using green IS in organizational contexts. Against the theoretical backdrop of DOI theory and activity theory, 55 different challenges and five overarching themes that hinder successful implementation from the employee's perspective were identified, as well as 44 different design suggestions that can help overcome these challenges. The theoretical discussion of the findings reveals that there are four critical dilemmas that arise from the tension between sustainability and the organizational context. The results challenge the current positivist dominance of research on green IS adoption and stimulate discussion about the role of voluntarism, privacy, intrusiveness, and extrinsic motivation in the design of motivational IS and sustainable behavior change interventions in the organizational context.

This study followed the guidance for conducting rigorous qualitative studies from Makri et al. [543] to ensure reliability and validity of the results. Through a multiple-case study, data was collected over a three-week period from different companies implementing a green IS. However, this study is not without limitations that open further avenues for further research in the context of green IS design in organizational contexts.

[543]: Makri *et al.* (2021)

First, all companies that participated in this study used the same green IS, namely the developed gamified application, as the basis for analyzing user perceptions and experiences. In particular, on the basis of the previous DSR design cycles, a smartphone-based application was chosen, but other formats such as tablet- or browser-based green IS [43] would be conceivable and may bring other challenges or benefits in the organizational setting. Therefore, considering other green IS in future studies would be valuable to ensure the dependability of this qualitative research.

[43]: Spence *et al.* (2018)

Since the study was conducted during COVID 19, the sample was limited to a single country. Differences in national cultural dimensions such as power distance, uncertainty avoidance, individualism-collectivism, masculinity-femininity, and short- or long-term orientation [603] could lead to different results that are worth exploring in future studies. Even though Germany is a representative country in Europe and Western culture, there are still many sub-cultural factors that may differentially influence users' perceptions and beliefs about sustainability and green behavior, as well as their experiences in using green IS. Therefore, research on challenges that hinder the adoption of green IS should be continued in different sub-cultural backgrounds and contexts.

[603]: Hofstede (2011)

In addition, future studies might consider more diverse samples. It could be useful, for example, to discuss the challenges and difficulties of using green IS depending on demographic or dispositional differences between samples. For instance, the relevance of different challenges hindering the adoption and use of green IS might differ between different age groups, while in the current study only two of the users studied belonged to Generation Z.

Finally, although the focus group participants were selected and recruited by company representatives to reflect the diversity of the company, their participation in the research project was nonetheless voluntary and therefore possibly subject to a degree of self-selection bias. While this is often difficult in research projects, future studies may find it useful to include participants through random sampling within a company with mandatory participation to include employees who may not have an initial interest in the topic of the research project in order to obtain more generalizable results.

The preceding qualitative evaluation of the MVP of the gamified app led to the following key insights for the further development in the third DSR cycle:

- Employees face a variety of challenges that must be overcome in order to successfully deploy the gamified application in an organizational context, which can be summarized into five themes:
  - (1) Supporting system understanding through onboarding and education
  - (2) Creating personal relevance through social pressure
  - (3) Facilitating the start of use through defaults
  - (4) Simplifying use by avoiding conflicts and defining the right triggers
  - (5) Reinforcing long-term motivation through extrinsic rewards, competence, and relatedness
- Employees mentioned several design suggestions (listed in Table 10.5 and Table 10.6) that provide valuable guidance on what features should be included in the further design of the gamified app
- Several challenges and design suggestions are conflicting and lead to critical dilemmas in the design of the gamified application that need to be considered in the next DSR cycle:
  - (1) Pressure versus voluntariness
  - (2) Control versus freedom
  - (3) Oblivion versus distraction
  - (4) Extrinsic versus intrinsic motivation

With careful consideration of the identified design dilemmas, the identified challenges and, in particular, the design suggestions of the employees form the basis for the final development of the envisioned gamified application in the third and final DSR cycle.

# Third DSR Cycle: Final Development and Summative Evaluation

# 11 Final Development of a Gamified App for Sustainable Employee Behavior



## 11.1 Definition of Objectives/Suggestion

The second evaluation of the artifact, in the form of the functional MVP developed in Chapter 9, through focus groups of employees who used the gamified application over a three-week period, has led to valuable insights about the challenges they encountered during adoption and use, overarching dilemmas for design decisions, and, in particular, ideas about how to resolve the challenges by improving the application in the third and final DSR cycle.

Consistent with the DSR paradigm, the first step in the third DSR cycle is again to refine objectives and suggestions for the artifact as a basis for subsequent design and development. Following the user story approach of the first and second DSR cycles, the existing user stories, their acceptance criteria and design constraints, and the non-functional design constraints are refined and extended by the findings of the previous evaluation and then prioritized for implementation in the final application to be developed in this cycle.

Table 11.1 and Table 11.2 summarize how the previous non-functional design constraints and user stories are refined and extended in this DSR cycle. The following section details the derivation of the refinements and added user stories based on the previous evaluation. For each user story, the named challenges and associated design solutions are considered to refine the acceptance criteria and design constraints. Completely new aspects are highlighted in green in Table 11.1 and Table 11.2, while aspects that are already known from the initial evaluation but were not implemented in the course of the MVP are highlighted in yellow. Third, acceptance criteria and design constraints that were not implemented in the MVP, but also do not pose a challenge to use, are dropped for further development and thus marked in red. If certain aspects are not yet included in a user story, a new user story is added. This results in a total of 25 user stories and 4 non-functional design constraints for the further design and development of the gamified application.

**NF1:** Easy access

Due to high employee demand during the initial evaluation of the artifact, the gamified application was implemented in the form of a smartphone application. Although employees mentioned challenges related to conflicts between the artifact and work tasks (C37) and that they forgot about the application in their daily work (C20), none of them mentioned the form as a particular obstacle, apart from the fact that the application was by default on the last page of the smartphone and thus had little visibility (C16). A browser application or embedding it in existing systems was not mentioned by any of the employees as a possible solution.

Table 11.1: Non-functional design constraints affecting the entire application that emerged based on the artifact evaluation in the second DSR cycle (entirely new information is marked in green, information that was also mentioned in the first cycle, but not implemented in the MVP, is marked in yellow, and information that was mentioned in the first cycle, but neither implemented in the MVP nor mentioned in the second cycle, is marked in red).

| Category | Design constraints |
|---|---|
| **NF1**: Easy access | ▸ The system should be implemented in form of a smartphone application<br>▸ The system should be implemented in form of a browser application<br>▸ The system should be integrated with existing systems in the corporate environment<br>▸ The system should be available in German and English |
| **NF2**: Seamless experience | ▸ The system should have a clear and intuitive structure<br>▸ The system should have a visible and easy navigation in one direction<br>▸ Navigation points and symbols should be clearly explained<br>▸ The system should include a back button<br>▸ The system should use overlays for actions and goals<br>▸ The system should have a modern design without shadows<br>▸ The system should use fresh colors<br>▸ The level status on the start page should link to the profile<br>▸ The system should have a dark mode (C27)<br>▸ The systems should have a design with high contrasts (C27) |
| **NF3**: Data security and fraud protection | ▸ The system should include control mechanisms to prevent fraud, such as proving actions with photos (C40)<br>▸ The system should include a consent form for data processing<br>▸ The system should protect data from external access<br>▸ The system should include rules that automatically restrict actions (C38) |
| **NF4**: Brand customization | ▸ The system should be customized to the brand of the company<br>▸ The system should include actions specific for the company (C28) |

**NF2:** Seamless experience

In general, employees seemed satisfied with the user experience in the gamified application. Some usability obstacles they encountered in the implementation phase (C24) or structural issues (C30) about where to track and perform actions are mainly related to **US20**, but not to the overall design of the application. Since the aesthetics of the application did not match their personal taste for some employees (C27), they mentioned that they would add a dark mode and opt for a design with higher contrasts.

**NF3:** Data security and fraud protection

In terms of data security, employees seemed to agree with the chosen procedure for registration and consent to data processing, emphasizing only that the content of the processing form should also comply with organizational rules (C5). However, employees were still concerned about imbalance or unfairness (C39) and a lack of clear rules (C38), control and protection against fraud (C40). Therefore, they emphasized that there should be more control mechanisms, such as proof of tracked actions with photos. In addition, they mentioned that the system should include rules that automatically restrict actions, e.g., ”vegetarian” lunch can only be checked off once a day.

**NF4:** Brand customization

Finally, for brand customization, employees added that the system should include company-specific actions, i.e., content, to enhance company-specific individualization (C28).

In terms of user stories, employees seemed generally satisfied with how **US1** (goals), **US4** (categories), **US5** (levels), **US7** (impact of behavior in terms of key metrics), **US9** (guidance for goal achievement), and **US12** (social comparison) were realized in the MVP. However, they brought a number of suggestions to support understanding of the application in the knowledge phase (C3, C4), to improve social interaction both for pressure in the persuasion phase (C13, C14) of adoption as well as in the implementation (C35, C36) and confirmation phases (C52, C53, C54) of use, to reduce effort, forgetting, and conflict with work tasks (C19, C20, C37), and to improve long-term motivation (C42), connection to the work environment (C46), and transparency (C48) and relevance of achievements (C49).

**US2:** As a user, I want to get a positive feedback message when I behave sustainably.

For **US2**, employees indicated that they would like to see a greater variety of different feedback animations when performing a sustainability action or achieving a goal, mainly for aesthetic reasons (C27). However, they also felt that the feedback animation was intrusive (C26) when they saw it after each action. Therefore, they added as new design constraint that the feedback animation should be displayed only once after multiple actions and should be faster than in the MVP.

**US3:** As a user, I want to gain points when I behave sustainably.

Regarding the point system (**US3**), employees mentioned that they perceive some imbalance between actions (C39) and added, as a design constraint to be considered in further development, that points for actions should be balanced throughout.

**US6:** As a user, I want to earn badges for specific achievements.

While badges (**US6**) were not prioritized in the MVP, which focused mainly on core functionalities, employees in the second evaluation emphasized the importance of this user story. In particular, virtual badges for specific achievements could help increase transparency of achievements (C48). While focus group participants did not elaborate on whether visibility of progress toward the badge or the constraint of clear milestones and variable difficulties were important to the implementation of the user story, they reported that they would be very happy to receive an early adopter badge as transparent recognition of their contribution (C48).

**US8:** As a user, I want to receive notifications and reminders that nudge me towards sustainable behavior.

Notifications and reminders (**US8**) were rudimentarily implemented in MVP, with notifications triggered by events in the application, such as an invitation to a goal. Employees stressed the importance of a comprehensive notification and reminder system to overcome oblivion in everyday work (C20) and to create recurring triggers for continued use (C25). Specifically, employees repeated that they would like to receive general reminders in the form of push notifications, but they also added that they would like to receive intelligent reminders based on their own behaviors and goals, as well as consistent notifications about in-app events. As a design constraint, employees added that the system should display an unread message badge on the application icon to provide an additional stimulus to check the application (C25).

**US10:** As a user, I want to receive tips on how to behave sustainably.

Similar to **US8**, employees again underscored the value of including tips and informational cues (**US10**) in the final application beyond simple reminders during the workday. Likewise, they mentioned tips as a solution to forgetting about the application during the workday (C20) and as a trigger to engage with the application (C25). On the other hand, none of the employees referred to quizzes as a learning element in the second evaluation.

**US19:** As a user, I want to receive an introductory onboarding when using the application for the first time.

Although onboarding for the app (**US19**) was conducted by the researcher in the second evaluation, employees felt that they missed an explanatory introduction to the app (C3) and that the functionality remained slightly unclear (C4). Thus, an introductory in-app onboarding, e.g., with the avatar Leafy, was highlighted as an acceptance criterion for successful onboarding. In addition, employees commented that they would also like to receive introductory informational materials outside of the app to promote adoption in the knowledge phase while supporting the connection between the app and the work environment (C46).

**US20:** As a user, I want to track my actions for sustainable behavior with minimal effort.

With respect to **US20**, employees encountered several obstacles related to usability (C24) and effort (C19), which were among the biggest challenges in the implementation phase of use. Although they were able to track actions with one click, employees reiterated that they wanted the ability to undo actions and that they wished the system would track actions automatically without user input to reduce effort. In addition, they added that the ability to set recurring actions, scan QR codes, or track actions in a widget, rather than having to track sustainable behaviors manually in the application, would be possible design solutions to reduce effort.

They also added a number of new design constraints for in-app tracking of actions. First, actions should be executable (not just favorable) on the action suggestions screen on the goal detail page. Second, multiple actions should be executable at the same time (and not one at a time). Third, actions should be deselectable by swiping down and easier to favorite to improve usability, and finally, favored actions should be color sorted in the overview for aesthetic reasons.

**US21:** As a user, I want to earn tangible rewards for specific achievements.

Tangible rewards (US21) were raised by employees as a principal solution to overcoming the challenges of long-term motivation (C42) and the cost-benefit ratio of using the application (C43). While the user story was not prioritized in the MVP due to the need for strategic support, employees expressed the importance of providing material incentives for sustainable behavior or at least, considering the appropriateness of incentives (C55), making donations to nonprofit organizations based on the performance of employees.

In addition to the existing user stories, employees mentioned another new aspect related to transparency of achievements that is not covered by the points and levels system, nor by key metrics and badges, and that is added as a new user story:

**US24:** As a user, I want to see a history of my performed actions.

Employees indicated that an overview of actions taken in the past could greatly assist them in reconstructing their behavior when tracking their actions at the end of a workday (C34), while also providing a way to transparently show what they have already done for sustainability (C48).

For the social aspects of the gamified application, employees did not add any design constraints, but they did add some acceptance criteria to the existing user stories indicating how they should be improved in the next DSR cycle.

**US11:** As a user, I want to see other users' profiles.

In general, employees seemed to like the personal profile with information about their accomplishments, but they repeated the importance of exploring other users' profiles, both to get role models for their own behavior (C14) and to be able to present their own achievements to others to give them social relevance (C49). The ability to like and comment on other users' accomplishments could further increase social praise for performance (C49). In addition, employees added the idea of including a timeline, like a social feed, with actions from colleagues to both increase the transparency of one's accomplishments to others (C49) and to gain new ideas for oneself (C14).

**US13:** As a user, I want to organize myself with colleagues in teams.

**US13** presents a particular challenge for the further development of the gamified application. While none of the employees explicitly mentioned that the ability to organize into teams and communicate with others would overcome challenges in using the gamified application, challenges such as social pressure (C13), interpersonal communication (C35), and interaction (C36) are likely to be addressed by such features. On the other hand, employees implicitly expected collaborative play as part of their suggestions to add company-set team milestones, for creating social pressure (C13) and personal relevance for participation (C9), and to provide a way to organize in company sites (and compete with other sites in a collaborative-competitive mode), for enhancing connection to the offline work environment (C46), and for creating a reason to celebrate team achievements (C54).

**US14:** As a user, I want to customize my presentation.

In **US14**, employees re-emphasized that they wanted to be able to showcase their achievements to others, in line with **US6**, to promote the social relevance of individual achievements (C49). Sharing accomplishments outside of their application on social media, on the other hand, was not mentioned by employees as a particularly important criterion. Rather, employees added that they wanted to upgrade the Leafy avatar with their earned points to give relevance to points earned through sustainable behavior (C49).

**US22:** As a user, I want to share my knowledge on sustainable behavior with others.

For **US22**, which was not prioritized in the MVP, employees stressed again that suggesting sustainability measures that they themselves think are relevant would be a good design solution to improve the individualization of the application (C47). However, they did not mention any filtering or voting process for the suggestions.

In addition to these predefined user stories, employees mentioned a new aspect related to social interaction that is added as a new user story:

**US25:** As a user, I want to gain recognition for achievements outside the app environment.

**US25** is inherently difficult to include as a user story for the gamified application because it must be realized outside of the gamified application. Employees wanted their employer to visualize the team's achievements on monitors in the company building as a role model for others not yet participating in the use of the application (C14) and to connect the application to the work environment (C46). They also valued personal recognition of their achievements outside the application by the company to increase their relevance (C49). Even though this user story is entirely dependent on the company and cannot be realized within the scope of app development, it is included for the sake of completeness.

Finally, employees emphasize hedonic aspects to enhance positive affective experiences and long-term relevance of the application.

**US15:** As a user, I want to be able to make personal settings for the applications' functionalities.

In terms of settings (**US15**), employees emphasized that if more notifications (US8) and tips (US10) are included, they would like to be able to individually decide which ones they would like to receive so that they do not receive personally irrelevant notifications which they then ignore (C21). In addition, employees added that they would like to be able to set lifestyle preferences to individualize the content and behavior of the application (C47), so that, for example, they are not suggested to take a bike if they do not own one.

**US16:** As a user, I want to unlock new content when I progress in the application.

Unlocking new content (**US16**) was cited by employees as one of the most important design solutions to overcome the decline in novelty (C44). While employees did not particularly emphasize the importance of surprising elements, such as Easter Eggs, they wanted to unlock more difficult actions for specific achievements that were obtained through progress in sustainable behavior.

**US17:** As a user, I want to see continuous new content in the application.

Continuous new content (**US17**) is the second most important design solution, along with content unlocking (**US16**), to overcome the decline in novelty (C44). Employees indicated that they would like to see recurring new content, such as during promotional periods. Both **US16** and **US17** indicate that it is very important to enrich content in addition to functionality in the final development cycle to promote use in the confirmation phase.

**US18:** As a user, I want to choose from different actions that I can perform for sustainability.

Similar to **US20**, employees mainly posed new design constraints to actions for sustainability (**US18**), as they seemed to like the feature in general, but saw aesthetic barriers (C27) and unclearness (C38). Specifically, employees cited that action descriptions should be structured with paragraphs and that action titles should be more specific to ensure that everyone understands the same thing about a particular action and the rules for taking it (C38) (e.g., it should be clearly expressed whether "ride your bike to work" refers to a traditional bike or an e-bike).

**US23:** As a user, I want to receive emotional reinforcement when I behave sustainably.

Finally, regarding **US23**, employees reemphasized the value of motivational messages that go beyond simple reminders or tips during the workday and would serve, in particular, as an emotional trigger for continued use (C25).

Table 11.2: Refined user stories based on the artifact evaluation in the second DSR cycle (entirely new information is marked in green, information that was also mentioned in the first cycle, but not implemented in the MVP, is marked in yellow, and information that was mentioned in the first cycle, but neither implemented in the MVP nor mentioned in the second cycle, is marked in red).

| User story | Acceptance criteria | Design constraints |
|---|---|---|
| **Utilitarian:** User stories that guide towards the intended behavioral outcomes | | |
| **US1:** As a user, I want to set goals for sustainable behavior. | ▸ The user receives different predefined, clear and achievable goal suggestions<br>▸ The user can select from different goal suggestions in order to customize their goals<br>▸ The user can sort and filter goal suggestions<br>▸ The user can browse all goals in the application<br>▸ The user receives varying daily goal suggestions | ▸ Suggested goals should be clearly separated from current goals<br>▸ Goals should be illustrated with appropriate pictures |
| **US2:** As a user, I want to get a positive feedback message when I behave sustainably. | ▸ The user sees a juicy feedback message with animations when they perform a sustainability action<br>▸ The user sees a variety of different feedback animations when they perform a sustainability action or achieve a goal (C27) | ▸ The feedback animation should be shown only once after multiple actions (C26)<br>▸ The feedback animation should be fast (C26) |
| **US3:** As a user, I want to gain points when I behave sustainably. | ▸ The user receives points when they perform a sustainability action<br>▸ The user can see how much points can be earned by a particular action<br>▸ The user can see the current progress in a goal based on the points earned | ▸ The points for actions should be balanced throughout (C39) |
| **US4:** As a user, I want to see how much points I earned in different categories. | ▸ The user can see a personal sustainability profile with a diagram that displays how many points they have earned in different categories | ▸ Categories should be clearly explained<br>▸ The system should have four categories: emissions, energy, water and waste<br>▸ Categories should be illustrated with suitable colors<br>▸ Category colors should be selected in such way that they do not indicate performance<br>▸ Categories should be illustrated with suitable icons or symbols |

Table 11.2: Refined user stories based on the artifact evaluation in the second DSR cycle (entirely new information is marked in green, information that was also mentioned in the first cycle, but not implemented in the MVP, is marked in yellow, and information that was mentioned in the first cycle, but neither implemented in the MVP nor mentioned in the second cycle, is marked in red).

| User story | Acceptance criteria | Design constraints |
|---|---|---|
| **US5:** As a user, I want to see my progress in a level system. | ▸ The user progresses in a level system when they earn points<br>▸ The user can see their progress in the level system | ▸ The scaling and relevance of the level system should be clearly explained to the user<br>▸ Each level should be given a title or designation |
| **US6:** As a user, I want to earn badges for specific achievements. | ▸ The user earns virtual badges for certain achievements (C48)<br>▸ The user can see their progress towards a badge | ▸ Badges should be linked to a clear milestone that is transparently explained<br>▸ Badges should have variable difficulties<br>▸ Focus group participants should receive an early adopter badge (C48) |
| **US7:** As a user, I want to see the impact of my behavior. | ▸ The user can see a dashboard with key metrics saved by all users of a company<br>▸ The user can see the timeframe of the key metrics on the dashboard<br>▸ The user can see personal sustainability statistics with key metrics saved by them<br>▸ The user can switch between company and personal sustainability statistics on the dashboard<br>▸ The user can see trend indicators for sustainability statistics | ▸ It should be clear to whom the key performance indicators relate<br>▸ Abstract units of the key metrics should be clearly explained |
| **US8:** As a user, I want to receive notifications and reminders that nudge me towards sustainable behavior. | ▸ The user receives general reminders for sustainable behavior in the form of push notifications (C20, C25)<br>▸ The user receives intelligent reminders for sustainable behavior in the form of push notifications (C20, C25)<br>▸ The user receives notifications from events in the application (C20, C25) | ▸ The system displays an unread messages badge on the application icon (C25) |
| **US9:** As a user, I want to get guided which actions I can take to achieve my goals. | ▸ The user can see an overview of sustainability actions they can take in their daily work<br>▸ The user receives personalized recommendations for sustainability actions | ▸ The link between goals and actions should be clearly illustrated<br>▸ The difference between goals and actions should be clearly explained |

Table 11.2: Refined user stories based on the artifact evaluation in the second DSR cycle (entirely new information is marked in green, information that was also mentioned in the first cycle, but not implemented in the MVP, is marked in yellow, and information that was mentioned in the first cycle, but neither implemented in the MVP nor mentioned in the second cycle, is marked in red).

| User story | Acceptance criteria | Design constraints |
|---|---|---|
| US10: As a user, I want to receive tips on how to behave sustainably. | ▸ The user receives informational hints about sustainable behavior throughout the workday (C20, C25)<br>▸ The user can play quizzes about sustainable behavior | |
| US19: As a user, I want to receive an introductory onboarding when using the application for the first time | ▸ The user sees an introductory onboarding on first use (C3)<br>▸ The user can access the onboarding later during use<br>▸ The user receives information materials outside of the app (C3, C4, C46) | |
| US20: As a user, I want to track my actions for sustainable behavior with minimal effort | ▸ The user can quickly access the screen to track their actions for sustainability<br>▸ The user can track actions with one click<br>▸ The user can easily favor actions<br>▸ The user can undo actions (C24)<br>▸ The system automatically tracks actions that a user performs outside of the application (C19)<br>▸ The user can set recurring actions that are tracked automatically (C19)<br>▸ The user can scan a QR-code outside of the app to track an action (C19)<br>▸ The user can track an action in a widget (C19, C24) | ▸ All actions for sustainability should be displayed on the start page<br>▸ Actions should be executable in the actions suggestions screen (C19, C24)<br>▸ Multiple actions should be executable at once (C19, C24)<br>▸ Actions should be deselectable by swiping down (C24)<br>▸ Actions should be easier to favor (C24)<br>▸ Favorite actions should be sorted by color (C27) |
| US21: As a user, I want to earn tangible rewards for specific achievements. | ▸ The company can give users tangible rewards for their sustainable behavior (C42, C43, C55)<br>▸ The company can make donations to non-profit organizations based on users' achievements (C42, C43, C55) | |
| US24: As a user, I want to see a history of my performed actions. | ▸ The user can see when they performed which actions in the past (C34, C48) | |

Table 11.2: Refined user stories based on the artifact evaluation in the second DSR cycle (entirely new information is marked in green, information that was also mentioned in the first cycle, but not implemented in the MVP, is marked in yellow, and information that was mentioned in the first cycle, but neither implemented in the MVP nor mentioned in the second cycle, is marked in red).

| User story | Acceptance criteria | Design constraints |
|---|---|---|
| **Social:** User stories that enable social interaction and positive social effects | | |
| **US11:** As a user, I want to see other users' profiles. | ▸ The user can see a personal profile with information on their performance<br>▸ The user can explore other users' profiles (C14, C49)<br>▸ The user can like and comment other users' achievements (C49)<br>▸ The user can see a timeline with actions taken by colleagues (C14, C49) | |
| **US12:** As a user, I want to see how I perform in comparison to others. | ▸ The user can see a leaderboard<br>▸ The user can measure themselves in direct competitions with other users<br>▸ The user can compare their key metrics with others | ▸ The leaderboard should only show the top 10 users |
| **US13:** As a user, I want to organize myself with colleagues in teams. | ▸ The user can organize themselves with other users in teams<br>▸ The user can communicate with others via messages<br>▸ The users can achieve milestones set by the company as a team (C9, C13)<br>▸ The users can organize themselves in company sites (C46, C54) | |
| **US14:** As a user, I want to customize my presentation. | ▸ The user can customize their personal profile<br>▸ The user can present their achievements to others (C49)<br>▸ The user can share their achievements on social media<br>▸ The user can upgrade Leafy as an avatar with earned points (C49) | |
| **US22:** As a user, I want to share my knowledge on sustainable behavior with others. | ▸ The user can suggest sustainability actions (C47)<br>▸ The user can vote for sustainability actions suggested by other users | |

Table 11.2: Refined user stories based on the artifact evaluation in the second DSR cycle (entirely new information is marked in green, information that was also mentioned in the first cycle, but not implemented in the MVP, is marked in yellow, and information that was mentioned in the first cycle, but neither implemented in the MVP nor mentioned in the second cycle, is marked in red).

| User story | Acceptance criteria | Design constraints |
|---|---|---|
| **US25**: As a user, I want to gain recognition for achievements outside the app environment. | ▸ The company visualizes team achievements on monitors in the company building (C14, C46)<br>▸ The company personally acknowledges user achievements outside the app (C49) | |
| **Hedonic:** User stories that foster individual relevance | | |
| **US15:** As a user, I want to be able to make personal settings for the applications' functionalities. | ▸ The user can make settings on notifications (C21)<br>▸ The user can customize the dashboard<br>▸ The user can make settings about their lifestyle (C47) | ▸ The settings should be accessible from the profile page |
| **US16:** As a user, I want to unlock new content when I progress in the application. | ▸ The user unlocks Easter Eggs when reaching specific achievements<br>▸ The user unlocks more difficult sustainability actions for specific achievements (C44) | |
| **US17:** As a user, I want to see continuous new content in the application. | ▸ The user receives suggestions for certain sustainability actions in specific promotional periods (C44)<br>▸ The user receives suggestions for certain sustainability actions based on the season | |
| **US18:** As a user, I want to choose from different actions that I can perform for sustainability. | ▸ The user can see detailed information on sustainability actions that explains the effect of the action<br>▸ The user can browse all actions<br>▸ The user can filter and sort actions | ▸ The system should clearly link actions to categories<br>▸ Action descriptions should be structured with paragraphs (C27)<br>▸ Action titles should be specific (C38) |
| **US23:** As a user, I want to receive emotional reinforcement when I behave sustainably. | ▸ The user receives motivational messages that encourage sustainable behavior (C25) | |

## 11.2 Final Application Design and Development

In the following, I will explain how the refined user stories summarized in Table 11.3, together with the specified acceptance criteria as well as design constraints and the non-functional design constraints Table 11.1, are considered in the design of the final application.

Of the non-functional design constraints, the form of a smartphone application in German and English is retained for *ease of access* (NF1), without further development of a browser application or integrations with existing enterprise systems, as these aspects were not considered in the evaluation of the MVP.

For a *seamless experience* (NF2), one employee suggested a dark mode and higher contrasts for aesthetic reasons. Since the suggestion came from a single person, while others did not criticize the overall aesthetic experience, it was decided not to revise the general design and leave it as it was in the MVP.

Regarding the issue of *data security and fraud protection* (NF3), employees' suggestions for fraud prevention would imply surveillance and restriction, such as requiring proof of actions or limiting the action execution for each action (which would mean that employees cannot check off actions they performed two days earlier if they do not use the application daily). Given the results of the evaluation discussed in Chapter 10, a design decision must be made for the *dilemma of control versus freedom* for the gamified application. In this case, I chose freedom at the expense of fraud protection to minimize potential barriers of privacy and surveillance concerns from both employee and organizational perspectives, and therefore the suggestions are not implemented in the final application.

Finally, *for brand customization* (NF4), some employees suggested including company-specific actions. Since the overall content was significantly expanded in the final application (from 50 actions to 137 actions and from 12 goals to 92 goals), the implementation of company-specific actions, which would have required extensive rewrites in the database schema, is not done in the final application.

For the functional user stories, I will focus on those that are refined and thus revised in this third DSR cycle. Accordingly, the implementation of user stories US1, US3, US4, US5, US7, US9, and US12 will not be presented again, as the MVP design is retained in the final application (to see their implementation, refer to Chapter 9). However, in the final application, the design constraint of *balanced points* (US3) is taken seriously and the point system (i.e., which action yields how many points) is revisited in the final application. Instead of key metrics, the points are intended to be a measure that rewards the difficulty of an action (e.g., dusting the heater every month saves a lot of energy and emissions but is relatively easy, while convincing colleagues to lower the temperature by 1 °C is much more difficult, even if it saves a comparable amount of emissions, and therefore the latter action earns more points than the former).

In using the application, the action selection process is redesigned to allow users to track their actions with minimal effort (US20).

Table 11.3: User stories and their implementation in the final application.

| User story | Included in the final application? | Implementation |
|---|---|---|
| **Utilitarian:** User stories that guide towards the intended behavioral outcomes | | |
| **US1:** As a user, I want to set goals for sustainable behavior. | √ | Not changed |
| **US2:** As a user, I want to get a positive feedback message when I behave sustainably. | √ | Figure 11.1, Figure 11.2 |
| **US3:** As a user, I want to gain points when I behave sustainably. | √ | Not changed |
| **US4:** As a user, I want to see how much points I earned in different categories. | √ | Not changed |
| **US5:** As a user, I want to see my progress in a level system. | √ | Not changed |
| **US6:** As a user, I want to earn badges for specific achievements. | √ | Figure 11.3, Figure 11.4 |
| **US7:** As a user, I want to see the impact of my behavior. | √ | Not changed |
| **US8:** As a user, I want to receive notifications and reminders that nudge me towards sustainable behavior. | √ | Figure 11.5, Figure 11.6 |
| **US9:** As a user, I want to get guided which actions I can take to achieve my goals. | √ | Not changed |
| **US10:** As a user, I want to receive tips on how to behave sustainably. | √ | Figure 11.5, Figure 11.6 |
| **US19:** As a user, I want to receive an introductory onboarding when using the application for the first time. | √ | Figure 11.6 |
| **US20:** As a user, I want to track my actions for sustainable behavior with minimal effort. | (√) | Figure 11.1 |
| **US21:** As a user, I want to earn tangible rewards for specific achievements. | (√) | Figure 11.7 |
| **US24:** As a user, I want to see a history of my performed actions. | √ | Figure 11.8 |
| **Social:** User stories that enable social interaction and positive social effects | | |
| **US11:** As a user, I want to see other users' profiles. | √ | Figure 11.8, Figure 11.9 |
| **US12:** As a user, I want to see how I perform in comparison to others. | √ | Not changed |
| **US13:** As a user, I want to organize myself with colleagues in teams. | √ | Figure 11.7, Figure 11.9, Figure 11.10 |
| **US14:** As a user, I want to customize my presentation. | √ | Figure 11.8 |
| **US22:** As a user, I want to share my knowledge on sustainable behavior with others. | × | Not implemented due to implementation effort, solved with workaround (email to researcher with action ideas and app update). |
| **US25:** As a user, I want to gain recognition for achievements outside the app environment. | × | Must be realized by the companies outside the application |
| **Hedonic:** User stories that foster individual relevance | | |
| **US15:** As a user, I want to be able to make personal settings for the applications' functionalities. | (√) | Figure 11.10 |
| **US16:** As a user, I want to unlock new content when I progress in the application. | √ | Figure 11.3, Figure 11.4 |
| **US17:** As a user, I want to see continuous new content in the application. | √ | Figure 11.5 |
| **US18:** As a user, I want to choose from different actions that I can perform for sustainability. | √ | Figure 11.1 |
| **US23:** As a user, I want to receive emotional reinforcement when I behave sustainably. | √ | Figure 11.5 |

Following the design constraints imposed by employees in the evaluation, actions are now *executable in the action suggestions screen*, and as can be seen on the left side of Figure 11.1, *multiple actions can be selected (or deselected) at once*. This also causes the *feedback animation to be displayed only once after multiple actions* are checked together (US2). The new design is based on item lists as known from e-commerce applications and also allows a check of the selection with the confirmation of the final action list, so that *undoing of wrongly selected actions* is no longer necessary. The actions overview has also been revised to *color-sort all actions (favorites and suggestions)*, and action detail information and favorization can now be accessed in a separate screen by clicking the information icon under an action (right side of Figure 11.1). Consistent with US18, *action descriptions are structured by paragraphs*, and *action titles are revisited to ensure they are specific and clear*. Although the suggestions for further automating or facilitating tracking to reduce effort, e.g., through *automatic tracking, recurring actions, widgets,* or *QR codes*, are very valuable, the implementation of these features is outside the scope of the development cycle in this DSR research project and remains as a valuable suggestion for the future.

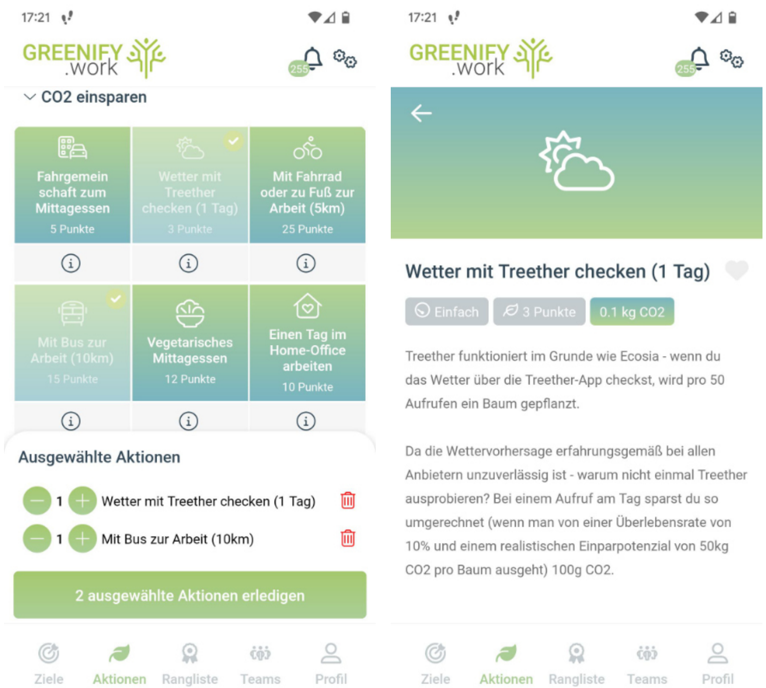


Figure 11.1: Screenshots of the action selection process in the final application (US2, US18, US20).

Regarding the feedback message that the user receives when an action is successfully performed (US2), the employees desired a variety of *different feedback animations for different actions or the achievement of goals*. To this end, four different feedback animations of Leafy are designed for the four categories of actions, supplemented by a fifth feedback animation for when actions of multiple categories are performed, and a sixth animation when a goal is achieved by the performed actions. To be able to connect several animations in a row, e.g. when an action has been performed (left side of Figure 11.2), a goal has been reached (right side of Figure 11.2) and a badge has been earned (left side of Figure 11.3), the feedback message is redesigned in the form of a *faster*, white modal, where several modals can be presented consecutively.

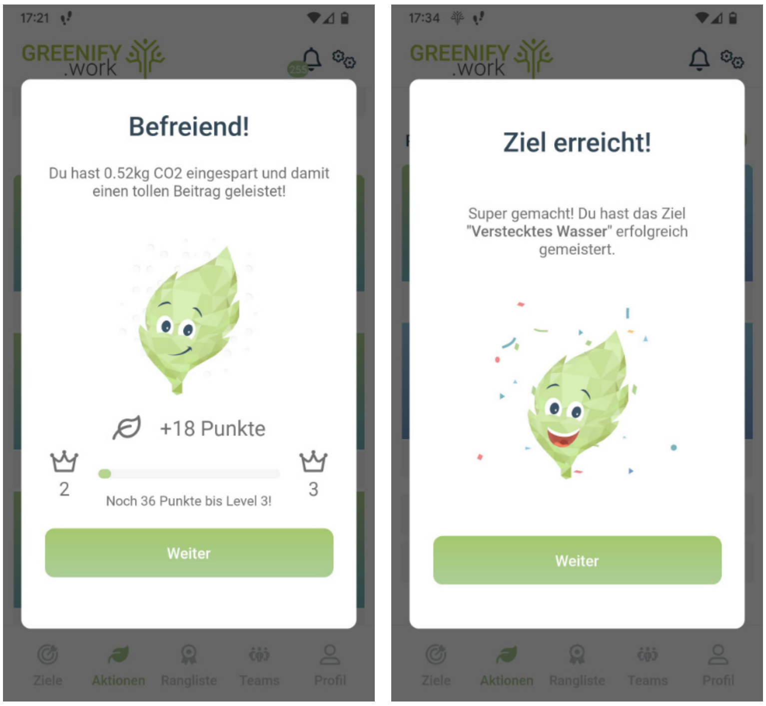


Figure 11.2: Screenshots of feedback animations in the final application (US2).

Badges (US6) are implemented in the final application as a new user story compared to the MVP. In total, 51 different badges (displayed in an overview on the profile, 15 of which are *Easter Eggs* (US16) indicated with a mysterious symbol, see left side of Figure 11.4) are defined for *specific achievements related to sustainable behavior*. An *early adopter badge* is included for focus group participants. For visible badges, users can *see their progress toward a badge* on the badge detail screen, where the badge icon, title, and clear description are displayed to *transparently explain the milestone to be achieved* (right side of Figure 11.3).

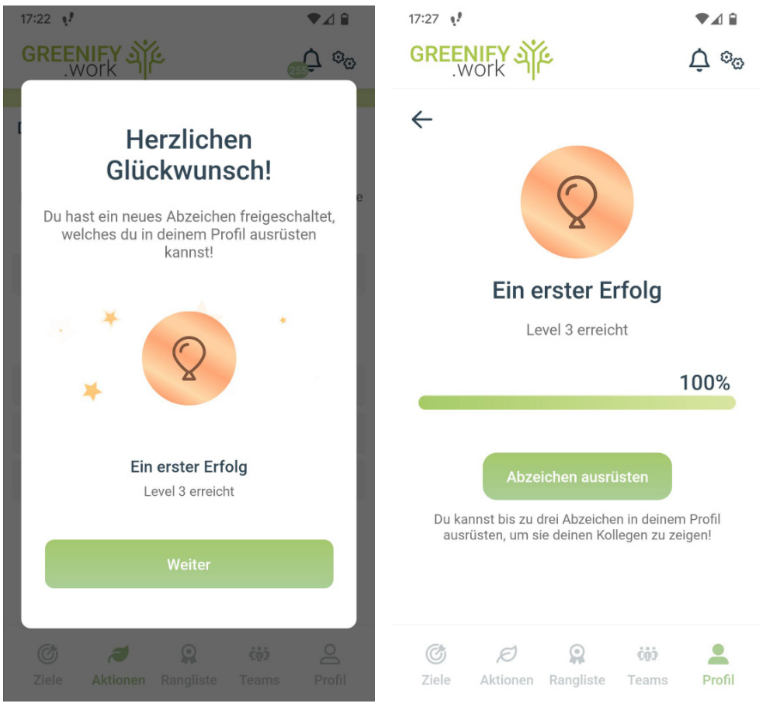


Figure 11.3: Screenshots of badges in the final application (US6, US16).

Badges have *variable difficulty* (e.g., an easy badge is to perform 10 actions for energy, while a harder badge is to win 10 competitions). When achieving a badge or finding an Easter Egg (e.g., using the app on Christmas eve or having found a bug because the app crashed), *more difficult sustainability actions are unlocked* (**US16**, shown on the right side of Figure 11.4).

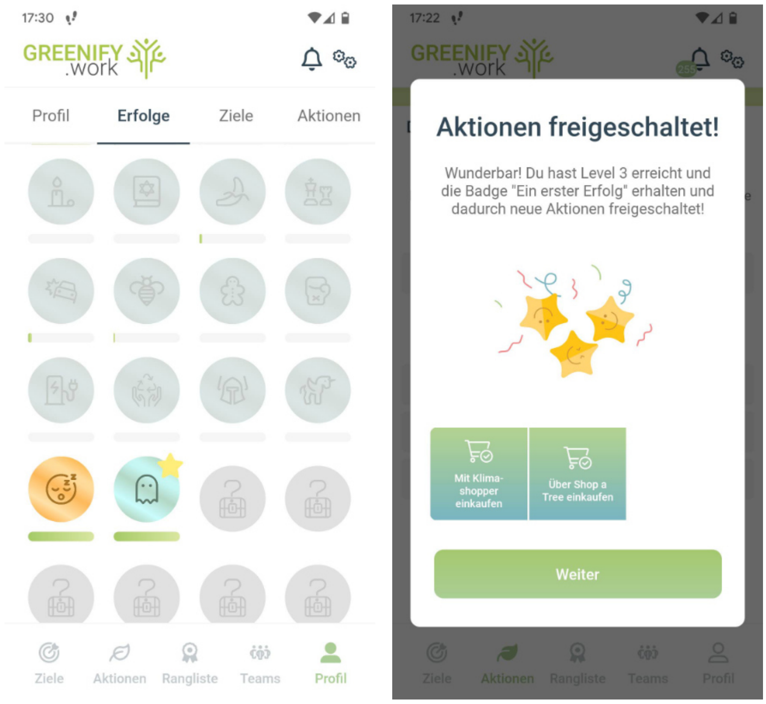


Figure 11.4: Screenshots of badges, Easter Eggs and unlockable content in the final application (**US6, US16**).

In accordance with employee emphasis, a comprehensive notification system (**US8, US10**) is developed that includes both *general reminders* and *tips for sustainable behavior* if the user has not set goals, as well as *smart reminders for specific goals* set by the user. Figure 11.5 shows examples of different types of notifications. On the one hand, notifications are sent for all *events in the application*, such as invitations to goals or teams, or when others have accepted the user's own invitations. On the other hand, to account for the *dilemma between oblivion and distraction* and not make the application so intrusive that it conflicts with daily work, a maximum of three other notifications are sent during typical work breaks. In the morning, before work begins, users receive either a *daily tip that matches their goals* or a *reminder that a goal is about to end* if it ends in a week or the next day. During lunch break, the second notification is sent in the form of a *reminder of actions related to the current goals*. And finally, in the evening after work, a *motivational message summarizing the user's achievements* (**US23**) is sent.

The notification system is also used to inform users about new content in the application (**US17**), for example, when a *new promotion period* starts, as shown on the right side of Figure 11.5. All notifications are not only displayed in the application, but also *sent as push notifications* to the smartphone (left side of Figure 11.6) and displayed as an *unread message badge on the application icon*.

**US19**, the introductory onboarding, is also implemented as a new user story compared to MVP. When using the application for the first time, *Leafy welcomes users to an onboarding tour*, which takes the form of a wizard that shows users the various features of the application and explains how

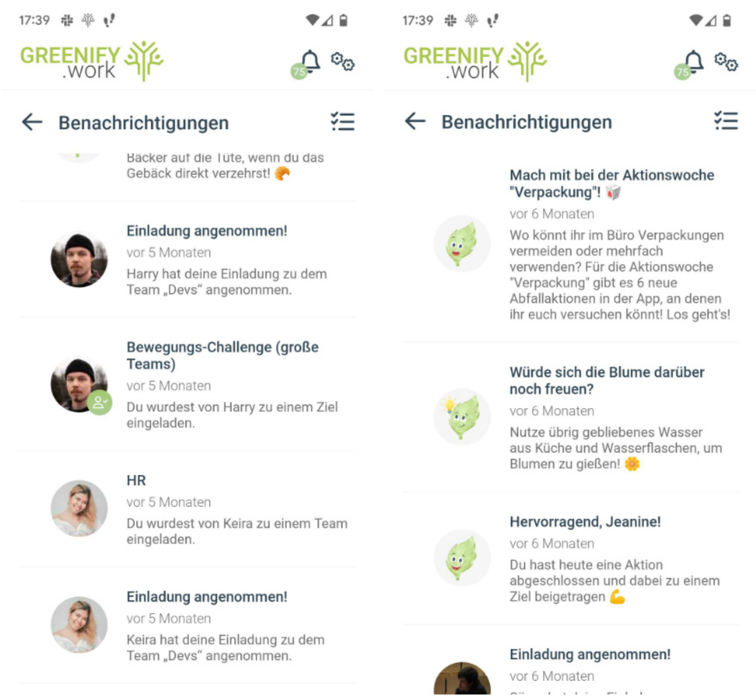


Figure 11.5: Screenshots of notifications, reminders, tips, motivational messages and promotion periods in the final application (**US8, US10, US17, US23**).

the application should be used (right side of Figure 11.6). Users can *access the onboarding at any time* through the application settings. In addition to the onboarding in the application, an *informational poster and staff presentation* are provided to employees in the final study.

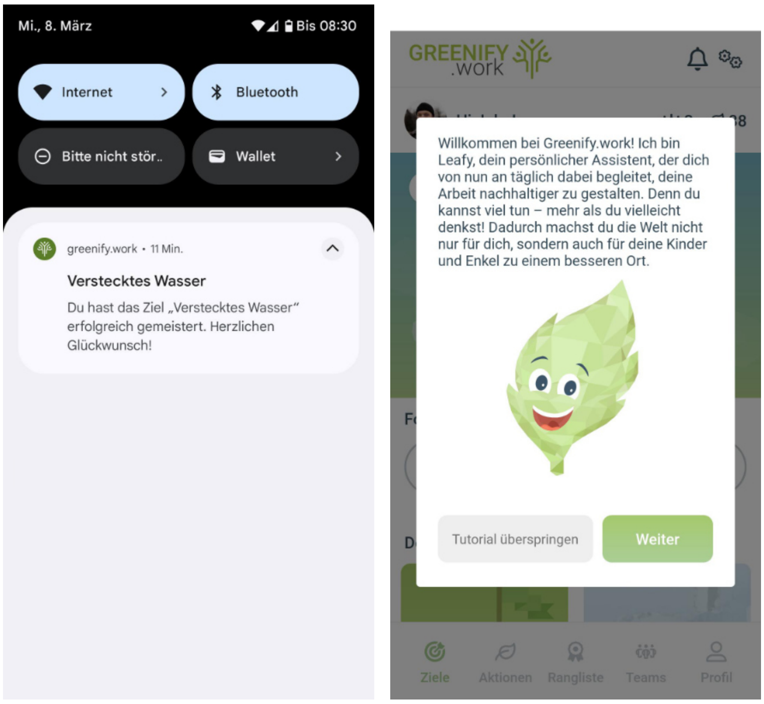


Figure 11.6: Screenshots of a push notification and the onboarding in the final application (**US8, US10, US19**).

The user story related to tangible rewards (**US21**) presents another particular challenge for the design and implementation of the gamified application. As became clear in the discussion of the evaluation in Chapter 10, the decision to introduce *extrinsic motivational incentives rather than focusing on fostering intrinsic motivation* is a particular dilemma in the organizational context and, in the specific case of the research project, also highly dependent on the companies participating in the field study. Therefore, the decision is made to develop and provide the functional basis for companies to be able to *define team milestones* (**US13**) that can be linked to either material rewards or donations when users reach them - but it is left to the company to decide how to distribute or realize these incentives. Since the decision for extrinsic rewards must be up to the company, the feature is designed to be optional and can be visible or invisible to each company separately. Figure 11.7 shows how the team goals defined by the company are displayed on the home screen of the application (left side of Figure 11.7), where users can transparently *see their team's progress towards the company goal*. On the details screen (right side of Figure 11.7), users can see what *rewards they can expect in the future* when they reach the next company goal. These can either be visible (with a title and description of the reward) or locked (a chest as a surprise reward).

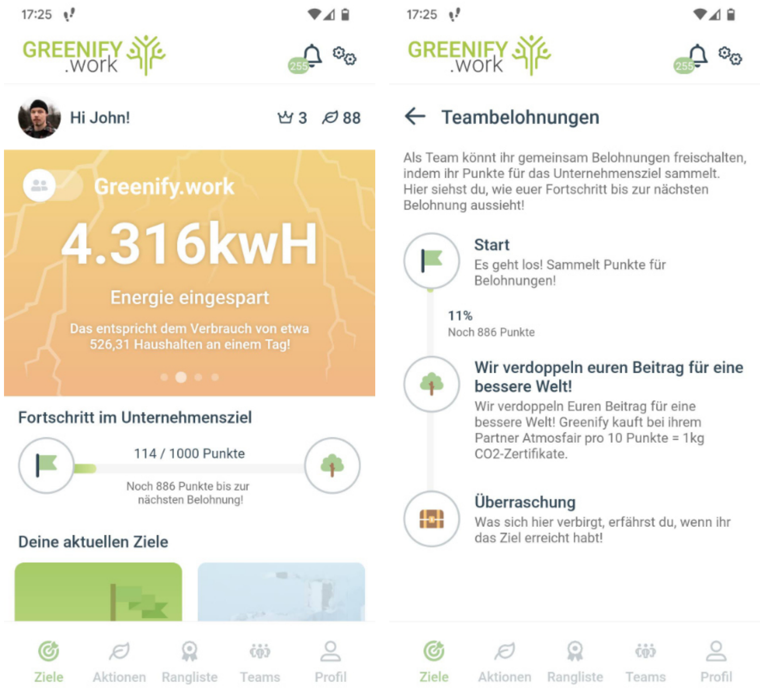


Figure 11.7: Screenshots of company-wide goals in the final application (US13, US21).

Employees added as a new user story that they would like to see a history of their actions (**US24**), which is added in the form of an *action timeline in the personal profile* (left side of Figure 11.8). Similarly, users can see the *timeline of their colleagues' actions* in their profile (**US11**, right side of Figure 11.8). *Other users' profiles* can be accessed at any point in the application where their thumbnails are displayed, such as in the leaderboard or the list of goal participants. By equipping received badges, users *can showcase their achievements to their peers* (**US14**) on their profile (Figure 11.8). However, since Leafy is intended to be a guide in the application rather than an avatar for reciprocal display, *Leafy cannot be customized, upgraded, or presented to other users*. The only user profile acceptance criterion not implemented (**US11**) is that of *liking or commenting on other users' accomplishments*, since in this case the gamified application would have represented a kind of social network, which presents greater challenges to enterprise deployment than a primarily individually-oriented application.

Although not a priority in MVP, the ability to *organize into teams* (**US13**) is included as a new feature in the final application. A novel screen linked to


Figure 11.8: Screenshots of the action history and other users' profiles in the final application (**US11, US14, US24**).

the main navigation of the application allows users to find existing teams and create new teams (left side of Figure 11.9). In a team detail screen (right side of Figure 11.9), users can see team members, points earned by team members in different categories, and a *feed of team member activities* (**US11**). Combined with the team leaderboard added to the ranking screen (left side of Figure 11.10), the team feature also allows users to *organize themselves into company sites* and *compete against each other at the team level*.

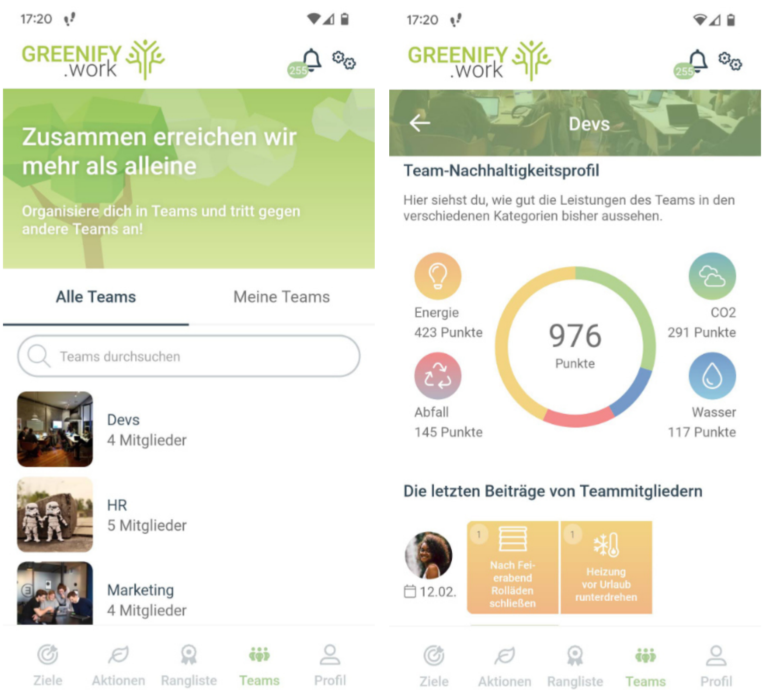


Figure 11.9: Screenshots of teams in the final application (**US11, US13**).

As for the settings for the applications' functionalities (**US15**), the advanced notification system is accompanied by the possibility to make *detailed* *settings for the different types of notifications* (right side of Figure 11.10). However, due to the implementation effort required for further customization, the suggestion to make *settings about one's lifestyle habits* to control notifications and tips is not implemented in the final application.


**Figure 11.10:** Screenshots of the team leaderboard and settings in the final application (US13, US15).

Finally, user-generated content in the form of suggestions for sustainability actions (US22) is not included in the final application as part of this research project, since the user story would have required a substantial implementation effort. However, as a workaround, users are invited to forward their ideas and suggestions to the researcher via email so that their input can be considered when the application is updated with new content. As mentioned in the previous section, US25 is also not implemented in the final application because it is a user story that can only be realized by the companies themselves, but the companies are encouraged to accompany the field study by recognizing and appreciating their employees' achievements outside the application.

In summary, the design and development of the final application carefully considers the user stories refined through the evaluation of the gamified app. 20 out of 25 user stories are fully implemented in the final application, and another 3 user stories are partially implemented to the extent possible. The following Chapter 12 presents the results of the summative evaluation of this developed artifact as the conclusion of the third and final DSR cycle of this research project.

# Study 6: Quantitative Investigation of Effects of the Gamified App on Sustainable Employee Behavior 12



## 12.1 Context and Aim of this Study

Meticulous consideration of the challenges and dilemmas that employees encountered while using the gamified application, as well as their suggestions for improving the application, guided the final development in Chapter 11. Following the FEDS framework, the developed artifact is now undergoing a summative evaluation in the real-world environment [103]. The goal is to investigate the actual impact of the gamified application on encouraging sustainable employee behavior at work in a field experiment. To derive effects on psychological, behavioral, and corporate outcomes, findings from employee surveys, log data from the gamified application, and corporate sustainability metrics are triangulated in line with the theoretical framework of this thesis presented in Chapter 3.

While previous research has examined various psychological and behavioral outcomes of gamification for sustainable behavior in work environments, past studies remain deficient in understanding how different design elements affect psychological outcomes and how psychological effects related to hedonic, gain, and normative goal frames translate into behavioral intentions and behavior change (see Chapter 4). With some notable exceptions in energy conservation (SDG 7) [78], [79], [82], [84], [86] and innovation (SDG 9) [75], [76], [313], prior research has largely neglected to examine the corporate outcomes of gamification interventions for sustainable employee behavior, particularly with respect to a holistic perspective that encompasses multiple dimensions of sustainable employee behavior (Chapter 4).

In order to address these research gaps, this study aims to *provide meaningful insights and a deeper understanding of how gamification impacts corporate sustainability* by investigating *psychological, behavioral, and corporate outcomes* of using the developed gamified application and, in particular, *different design elements* within the application, at work. In doing so, it seeks to both advance theoretical understanding of the potential of gamification as an intervention for corporate sustainability performance and to derive recommendations for how gamification can best be designed to achieve positive psychological, behavioral, and corporate outcomes. To pursue this goal, this work draws on goal-framing theory [133], the TPB [166] and the general aspects of user experience in motivational IS TPB [249] as a theoretical framework for quantitatively examining the outcomes of gamification (design elements) at psychological, behavioral, and corporate levels.

**Publication of this study.**

A subset of the data from this study was analyzed in a different form and published in [95] J. Krath, B. Morschheuser, H. F. O. von Korflesch, and J. Hamari, "How to increase sustainable engagement in the workplace through green IS: the role of instructional and motivational design features", in Thirty-first European Conference on Information Systems (ECIS 2023), Kristiansand, Norway, Jun. 2023, p. 244, `https://aisel.aisnet.org/ecis2023_rp/244/`.

[103]: Venable *et al.* (2016)
[78]: Hafer *et al.* (2017)
[79]: Kaselofsky *et al.* (2020)
[82]: Lou *et al.* (2019)
[84]: Oppong-Tawiah *et al.* (2020)
[86]: Iria *et al.* (2020)

[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[313]: Colabi *et al.* (2022)

[133]: Lindenberg *et al.* (2013)
[166]: Ajzen (1991)
[249]: Hamari *et al.* (2015)

## 12.2 Theoretical Background

Building on research gaps from previous studies that scarcely used theoretical foundations to evaluate their gamified interventions (Chapter 4), the current study employs a theory-driven approach to evaluate the impact of gamification on sustainable employee behavior, drawing on both the TPB [166] as a general behavioral theory well suited to explain sustainable workplace behavior [168], [169] and goal-framing theory [133] as a topic-specific theory of the psychological drivers of sustainable behavioral intentions.

[166]: Ajzen (1991)
[168]: Morren *et al.* (2016)
[169]: Katz *et al.* (2022)
[133]: Lindenberg *et al.* (2013)

In particular, the three determinants of behavioral intention from the TPB (i.e., pro-environmental attitude, subjective norm, and perceived behavioral control) are examined as gain goal frame-related determinants of behavioral intention, i.e., the willingness to engage in a behavior [604], filling the gap of previous studies that have mainly focused on hedonic and normative goal frame-related determinants (Chapter 4).

[604]: Ajzen *et al.* (2010)

Moreover, hedonic enjoyment of sustainable behavior, which refers to pleasure and satisfaction from a behavior [605], is added as a hedonic goal-frame-related determinant of behavioral intention. In addition, perceived environmental knowledge, which refers to a person's awareness of environmental issues and the consequences of their actions on the environment [606] and thereby reflects the VBN [160] and NAM [157] aspects of awareness of consequences and ascription of responsibility highlighted in the normative goal frame [133], is added as determinant of behavioral intention. Finally, the influence of behavioral intention on self-reported sustainable behavior is examined, in line with the assumptions of the TPB [166]. Based on this model, which is presented in Figure 12.1, the influence of the gamified application as a determinant on the trajectory toward sustainable behavior is examined.

[605]: Pelletier *et al.* (1998)
[606]: Rausch *et al.* (2021)
[160]: Stern *et al.* (1994)
[157]: Schwartz (1977)

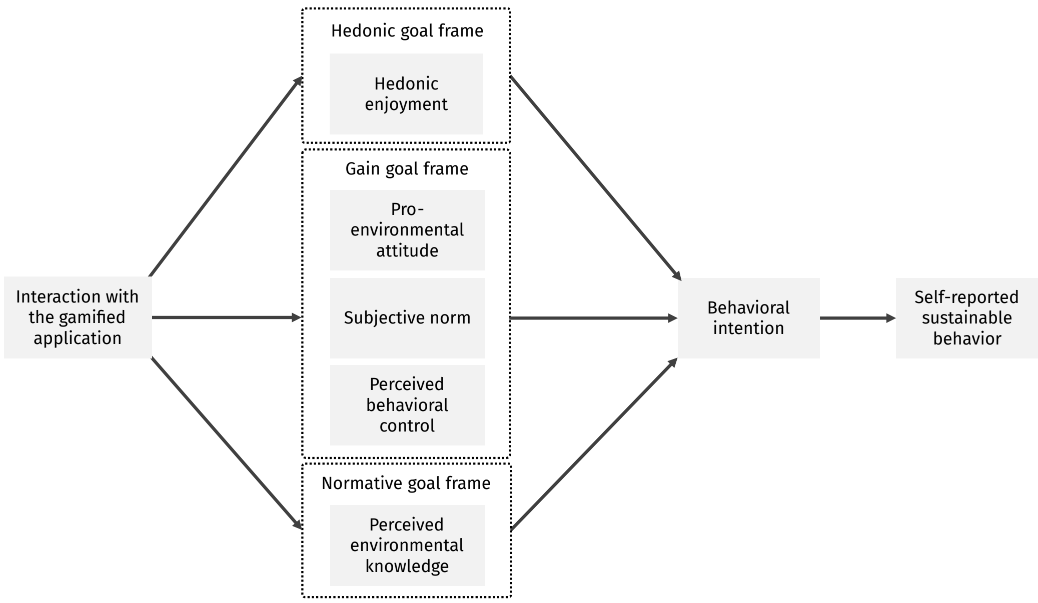


**Figure 12.1:** Research model for psychological outcomes of the gamified application.

In addition, this study draws on the general aspects of user experience in motivational IS [249] that have consistently guided the design and evaluation of the gamified application so far to examine the relative impact of different design elements on sustainable behavior.

[249]: Hamari *et al.* (2015)

Specifically, as illustrated in the model in Figure 12.2, the impact of using various utilitarian, hedonic, and social elements [249] implemented in the gamified application (see Table 11.3 in Chapter 11) on the sustainability actions performed in the application, i.e., observed sustainable behavior rather than self-reported sustainable behavior, is explored to gain further insight into the relative impact of these different design elements on eliciting behavioral outcomes.

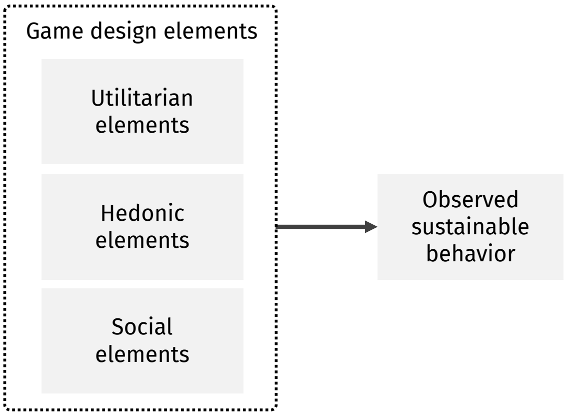


Figure 12.2: Research model for behavioral outcomes of the gamified application.

Finally, the psychological and behavioral perspectives are combined and synthesized into an overarching research model (Figure 12.3) that examines not only how the use of the gamified application itself, but also how the use of various utilitarian, hedonic, and social design elements [249] affect gain-, hedonic-, and normative goal-frame-related psychological outcomes [133], and thereby influence behavioral intention and self-reported sustainable behavior [166].

[249]: Hamari *et al.* (2015)

[133]: Lindenberg *et al.* (2013)

[166]: Ajzen (1991)

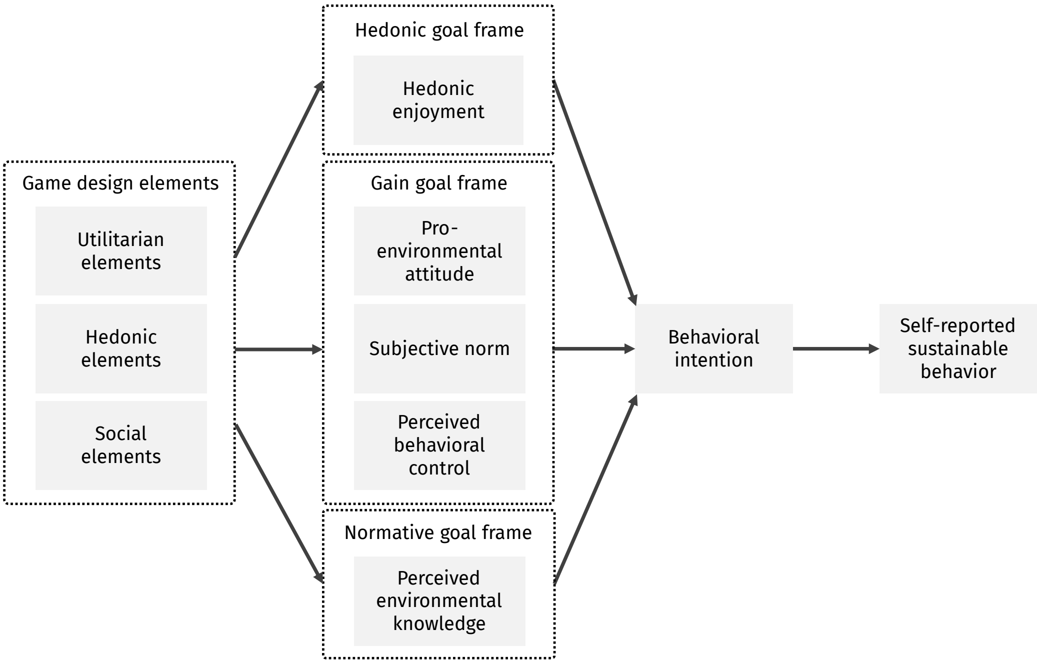


Figure 12.3: Research model for psychological outcomes of different elements in the gamified application.

Hence, the three theoretical lenses serve to develop a deep understanding of how different gamification design elements impact pathways to sustainable employee behavior in the workplace and ultimately drive corporate outcomes in terms of energy and heat consumption (SDG 7), water consumption (SDG 6), emissions from business travel (SDG 11), as well as waste reduction, recycling, and paper consumption (SDG 12).

## 12.3 Research Method

To examine the psychological, behavioral, and corporate outcomes explained in the previous section, a quantitative field experiment is conducted. Field experiments, while having limited control compared to laboratory experiments, are particularly valuable in discovering effects on behavior in the real world, with all the confounding influences that can occur [607]. Consistent with previous studies in the field of IS [608], the field experiment uses a *quasi-experimental* approach in that there is no control group that does not receive the gamified application so as not to create negative social dynamics in the companies because some individuals are excluded from participation. Rather, the field experiment is based on an *exploratory within-subjects design* in which no predefined hypotheses are tested.

[607]: Harrison *et al.* (2004)

[608]: Franz *et al.* (1986)

While most previous gamification studies examined the effects of short-term interventions that lasted between one and seven weeks [82], [84], [87], the goal of this study, consistent with the urgent calls of previous research cautioning against interpreting results that originate only from a potential novelty effect [48], is to explore the long-term effects of gamification on sustainable employee behavior. Therefore, the gamified application is introduced for a period of six months to investigate how long employees participate in the intervention and use the gamified application in their daily work. Therefore, the first research question is stated as follows:

[82]: Lou *et al.* (2019)
[84]: Oppong-Tawiah *et al.* (2020)
[87]: Wunsch *et al.* (2016)

[48]: Koivisto *et al.* (2019)

**RQ 1:** *How does employees' use of the gamified application evolve over time?*

Second, in terms of *psychological and behavioral outcomes* consistent with the theoretical model based on goal-framing theory [133] and the TPB [166], the goal is to understand the process of how the application influences employees' psychological experiences and self-reported sustainable behaviors in the workplace. Accordingly, the following research questions will be answered:

[133]: Lindenberg *et al.* (2013)

[166]: Ajzen (1991)

**RQ 2:** *How does the use of the gamified application influence antecedents and self-report sustainable employee behavior?*

**RQ 3:** *How do employees subjectively experience using the gamified application to support them in sustainable behaviors at work?*

Third, for the *relative effect of different gamification design elements on psychological and behavioral outcomes* consistent with theoretical models based on the general aspects of user experience in motivational IS [249], the aim is to gain an understanding of how different design features influence both observed sustainable behavior and self-reported sustainable behavior with its antecedents of employees in the workplace. The research questions to be answered are:

**RQ 4:** *How does the use of different design features of the gamified application influence observed sustainable employee behavior?*

**RQ 5:** *How does the use of different design features of the gamified application influence antecedents and self-report sustainable employee behavior?*

Finally, in terms of *corporate outcomes*, various metrics such as monthly water, gas, and electricity consumption in corporate buildings, emissions from business travel, and the amount of waste generated by employee activities are examined to answer the following research questions:

**RQ 6:** *Which effects does the use of the gamified application have on corporate sustainability measures?*

**RQ 7:** *Are there differences in the effect of the gamified application between companies of different industries and sizes?*

### 12.3.1 Data Collection

To answer the research questions, different data were collected and triangulated. In particular, event logs from the application were considered along with employee surveys and a comprehensive elicitation of key metrics in the companies both in the year prior to the intervention and in the period of the field experiment.

A total of seven companies from different industries and two universities participated in the field experiment (see Table 12.1 in the Participants section). The gamified application was made available to employees over a period of six months. Due to the content focus of the app, employees who work in administrative, strategic, or operational areas and whose primary workplace is an office (rather than a manufacturing facility or fully outsourced site) were targeted.

During use, log data from the gamified application was collected by tracking each click within the app along with a pseudonymous user ID and timestamp. Clicks included, for example, clicking on a goal detail page, clicking on the ranking tab with the leaderboard, or clicking on the profile tab with one's profile. Each log was stored in a NoSQL database with an ID and a predefined identifier (like SEE_PROFILE). In this way, a total of 65,302 logs were collected from 297 employees, which serve as a basis for analyzing the overall engagement with the application over time (**RQ1**). The database for examining the relative influence of utilitarian, hedonic, and social elements (**RQ4, RQ5**) consists of a subset of 37,265 logs. The variables were operationalized by taking the sum of each user's logs related to the use of the main utilitarian, hedonic, and social elements of the gamified application (see Table 11.3 in Chapter 11). In addition to these logs, the sustainability actions performed by the employees (i.e., the actual execution of the actions suggested in the app, e.g., "Turn off the lights before you leave work") were logged for each user. There was no additional control on this logging, i.e., employees self-reported whether they had performed an action without external verification. However, because actions performed by colleagues were displayed on their profiles, there was a form of social control against cheating if participants recorded unrealistic actions (e.g., that they ate vegetarian meals 15 times in one day). A total of 34,670 actions were logged during the study period, operationalizing the dependent variable observed sustained behavior.

Moreover, employees received an online survey on determinants and self-perceptions of sustainable behavior at the beginning of the field experiment and at recurring bi-monthly intervals. To elicit the psychological determinants of behavioral intention, behavioral intention, and self-reported sustainable behavior, previously validated scales based on goal-framing theory [133] and the TPB [166] were used. Specifically, for pro-environmental attitude (consisting of instrumental attitude and experiential attitude), subjective norm (consisting of injunctive norm and descriptive norm), perceived behavioral control (consisting of capacity and autonomy), and behavioral intention, items were drawn from the studies of Han [171], Sabbir et al. [154], Blok et al. [173], Mancha and Yoder [609], and Yuriev et al. [163], all based on the original recommendations for TPB studies by Ajzen and Fishbein [604]. For hedonic enjoyment, Waterman's scale [610] was adapted for the context of sustainable behavior. Perceived environmental knowledge was operationalized using four items adapted from Rausch and Kopplin [606]. Finally, self-reported sustainable behavior was captured using Bissing-Olson et al.'s Environmentally Friendly Behavior Scale, developed explicitly for workplace sustainability [153], consisting of task-related PEB and proactive PEB. For transparency, all items used in the survey, along with their measurement and sources, are listed in Section E.1.

[133]: Lindenberg *et al.* (2013)

[166]: Ajzen (1991)

[171]: Han (2015)

[154]: Sabbir *et al.* (2022)

[173]: Blok *et al.* (2015)

[609]: Mancha *et al.* (2015)

[163]: Yuriev *et al.* (2020)

[604]: Ajzen *et al.* (2010)

[610]: Waterman (1993)

[606]: Rausch *et al.* (2021)

[153]: Bissing-Olson *et al.* (2013)

Furthermore, employees were asked about their experiences with the gamified application to complement the quantitative results with qualitative insights (RQ3). Demographic data collected included age, gender, and team size. To allow for comparison within subjects after using the application (RQ2) and to link survey results to use of different game design elements (RQ5), employees were also requested to provide a pseudonymous, five-digit profile ID that was displayed in their profile in the gamified application.

Finally, four of the companies provided monthly sustainability-related key metrics (e.g., building energy consumption, gas consumption, water consumption, or waste generation) for both the field study period and a comparison period in the year prior (RQ6, RQ7). Table 12.1 in the Participants section provides information on which key metrics were provided by which company.

### 12.3.2 Participants

Participating companies were diverse in terms of their operations and size. Company A was a medium-sized (± 400 employees) industrial software provider, Company B was a small (± 25 employees) media agency, Company C was a medium-sized (± 150 employees, out of them ± 25 office employees) glass manufacturing company, Company D was a medium-sized (± 280 employees) engineering firm, Company E was a medium-sized (± 290 employees) regional bank, Company F was large (± 3.200 employees) telecommunications provider, and Company G was a large (± 1.500 employees) IT-consultancy, all based in Germany. However, especially in the large companies, not all employees were invited to participate; instead, the

Table 12.1: Companies participating in the field study.

| Company | Type | No. of employees | Users | Participation rate | Provided key metrics |
|---|---|---|---|---|---|
| Company A | Industrial software provider | ± 400 | 39 | 9,75% | Electricity, gas, CO2 emissions from vehicle fleet and business travel, water |
| Company B | Media agency | ± 25 | 13 | 52% | Electricity, waste (divided by residual waste, recycling waste, and paper waste) |
| Company C | Glass manu-facturer | ± 150 (± 25 in office) | 14 | 56% | Electricity, gas, water, paper usage for printing |
| Company D | Engineering | ± 280 | 27 | 9,64% | - |
| Company E | Regional bank | ± 290 | 46 | 15,86% | - |
| Company F | Telecommu-nications provider | ± 3.200 (± 300 in pilot divisions) | 38 | 12,67% | - |
| Company G | IT consultancy | ± 1.500 (± 120 in pilot divisions) | 43 | 35,8% | - |
| University A | University | ± 1.500 | 14 | 0.93% | |
| University B | University | ± 14.000 | 66 | 0,47% | - |

gamified application was treated as a pilot project that was introduced only in subdepartments of ± 300 (Company F) to ± 120 (Company G) employees. In addition, employees of two universities (University A and University B) participated in the field study. Table 12.1 summarizes the participating companies and participation rates of employees.

A total of 300 employees participated in the field study, with companies achieving a participation rate of 9.64-56% of all employees and universities achieving a participation rate of 0.47-0.93% of all employees (distribution shown in Table 12.1). In consideration of the protection of personal data, no other employee demographic data were collected at the time of registration for participation.

Of the 300 participating employees, 297 interacted with the gamified application at least once (while 3 did not log in even once), thus forming the database for RQ1. Of these 297 users, 247 performed at least one sustainability action (as a measure of observed sustainable behavior) within the application. Therefore, the logs of these 247 users (64,310 logs, 34,670 actions) are used as the basis for examining RQ4.

Further, 147 employees completed the first employee survey at the beginning of the field experiment, and 53 of them also completed the second employee survey. In addition, 26 employees completed only the second survey but not the first, so no effect can be measured. In the third recurrent interval, only 4 employees completed the third survey, with only 1 matching the previous surveys. Figure 12.4 illustrates the evolution of participants. Because this data set is insufficient to draw statistical conclusions and the use of the gamified application is essentially limited to two months (see Figure 12.5 in the Results section), the paired set of 53 employees after the second survey, of which one participant was excluded because his ID could not be matched with a user in the gamified application, so it could not be ensured that he used the application during the field experiment, forms the basis for examining RQ2, RQ3, and RQ5.

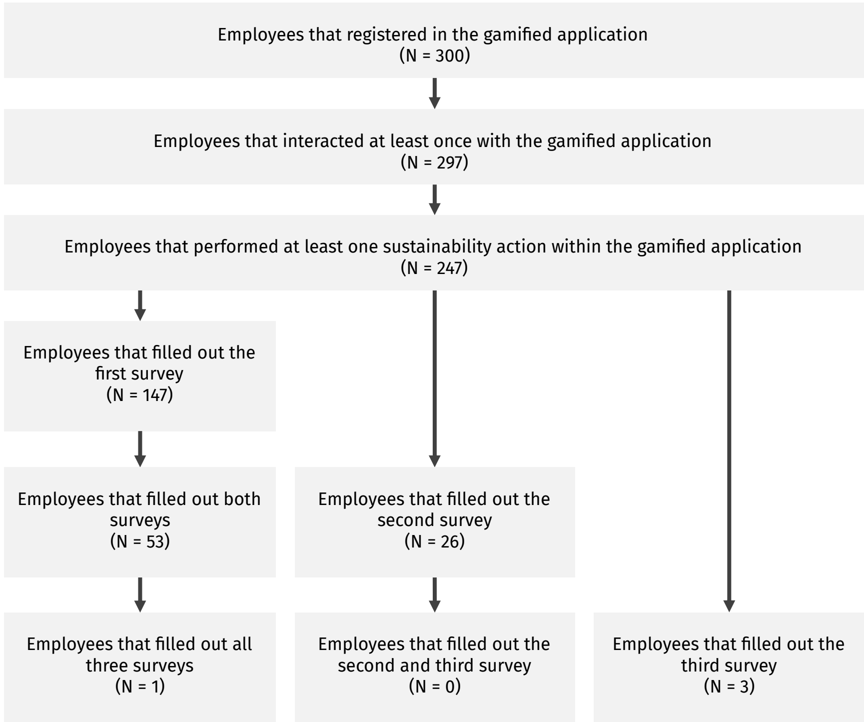


**Figure 12.4:** Development of participants in the field experiment.

Of the final 52 participants, 26 (50%) identified themselves as male and 26 (50%) as female. The mean age was (*M = 38.5, MD = 34.5, SD = 11.9, min = 22, max = 63*). Most employees worked in teams of 1-5 people (*N = 23*), followed by 11-20 (*N = 14*) and 6-10 (*N = 12*) people. Only 3 employees interact with 20 people or more on a daily basis. To link the qualitative findings to these participants, Table 12.2 lists all participants who completed both surveys.

### 12.3.3 Data Analysis

To answer the research questions based on the collected data, several data analysis methods were combined.

First, to answer **RQ1**, the event logs and sustainability actions were transformed to replace the absolute timestamp with a relative timestamp of days after registration based on each user's registration date. The reason for this transformation is that users did not all register at the same time, but some employees joined weeks or even months after the field experiment began, and analysis of usage over time would then be disrupted by new users. After transformation, event logs and sustainability actions were analyzed descriptively in terms of their evolution over time in relation to days after registration.

[611]: Hair *et al.* (2019)

Second, a paired two-tailed t-test and SEM were conducted to examine **RQ2**. For this purpose, the reliability, convergent validity and discriminant validity of each scale was first checked as a prerequisite for the analysis [611], and the mean of the items of each scale was calculated to form the constructs (e.g., pro-environmental attitude, perceived behavioral control, and subjective norm). Afterwards, all potential influences of age, gender, and team size were controlled. Descriptive statistics from both the pretest (first survey at the beginning of the field experiment) and posttest (second survey two months after) were subsequently analyzed, followed by the

| No. | Gender | Age | Team Size | No. | Gender | Age | Team Size |
|---|---|---|---|---|---|---|---|
| P1 | male | 51 | 11-20 | P27 | male | 27 | 1-5 |
| P2 | male | 32 | 1-5 | P28 | female | 27 | 1-5 |
| P3 | female | 27 | 11-20 | P29 | female | 29 | 1-5 |
| P4 | female | 23 | 1-5 | P30 | female | 49 | 11-20 |
| P5 | female | 42 | 11-20 | P31 | male | 42 | 11-20 |
| P6 | male | 23 | 1-5 | P32 | female | 39 | 1-5 |
| P7 | female | 27 | 6-10 | P33 | female | 32 | 1-5 |
| P8 | male | 22 | 6-10 | P34 | male | 41 | >20 |
| P9 | female | 63 | 1-5 | P35 | female | 50 | >20 |
| P10 | male | 27 | 1-5 | P36 | female | 25 | 1-5 |
| P11 | female | 32 | 11-20 | P37 | male | 31 | 1-5 |
| P12 | female | 31 | 11-20 | P38 | male | 26 | 1-5 |
| P13 | female | 43 | 6-10 | P39 | female | 27 | 6-10 |
| P14 | female | 30 | 1-5 | P40 | male | 60 | 11-20 |
| P15 | male | 45 | 1-5 | P41 | male | 26 | 6-10 |
| P16 | female | 58 | 1-5 | P42 | male | 48 | 11-20 |
| P17 | female | 51 | 6-10 | P43 | male | 30 | 6-10 |
| P18 | female | 56 | 6-10 | P44 | female | 33 | 6-10 |
| P19 | female | 52 | 1-5 | P45 | male | 51 | 11-20 |
| P20 | male | 57 | 1-5 | P46 | male | 29 | 6-10 |
| P21 | male | 42 | 6-10 | P47 | female | 50 | 11-20 |
| P22 | male | 61 | 1-5 | P48 | female | 28 | 6-10 |
| P23 | female | 26 | 1-5 | P49 | female | 34 | 11-20 |
| P24 | male | 37 | 1-5 | P50 | male | 44 | 6-10 |
| P25 | male | 35 | 1-5 | P51 | male | 53 | 1-5 |
| P26 | male | 28 | 11-20 | P52 | male | 51 | >20 |

**Table 12.2:** Survey participants of the field experiment.

execution of the two-tailed paired t-test. The two-tailed test was chosen because of the exploratory nature of the analysis, i.e., because no prior hypotheses were made about the direction of the effect [612]. Additionally, to explore the pathway to sustainable behavior, SEM with two-tailed significance calculation was conducted in SmartPLS, with the constructs modeled as latent variables and the items modeled as observed variables, to analyze the relationship between the psychological determinants, behavioral intention, and self-reported sustainable behavior.

[612]: Pillemer (1991)

**A note on SmartPLS.**

SmartPLS uses Partial Least Squares (PLS)-SEM and has gained increasing popularity across various research fields [613]. PLS-SEM is particularly suitable if the objective is to explore theoretical extensions of established theories and sample sizes are small, but the model still contains many indicators and relationships, and it is robust to lack of normal distribution [611]. Therefore, it is chosen as SEM method for this analysis.

In this model, the latent variables can be considered reflective, i.e., the observable variables are manifestations of the latent variables [614] and individual items can generally be omitted without changing the meaning of the construct [615], with attitudes or intentions being typical examples [616]. Therefore, consistent with recommendations from IS research [617], a *consistent PLS-SEM* with bootstrapping of 10,000 samples was used for analysis to reduce the likelihood of Type II errors. To examine the influence of using the gamified application, overall interactions with the gamified application were examined as a predictor of psychological outcomes.

[614]: Schuberth *et al.* (2018)

[615]: Sarstedt *et al.* (2016)

[616]: Jarvis *et al.* (2003)

[617]: Dijkstra *et al.* (2015)

In order to investigate employees' subjective experiences of using the app to support sustainable behavior (**RQ3**), a qualitative content analysis was conducted according to Mayring's approach [547]. Inductive coding was chosen due to the exploratory nature of the study (data-driven approach [549]). All qualitative responses from the second employee survey were uploaded into the data analysis tool MAXQDA. The inductive coding process involved (1) determining the level of selection and abstraction of categories to be coded, (2) linking text passages with the defined level of abstraction either to existing categories or forming a new category, (3) revisiting cat-

[547]: Mayring (2015)

[549]: Mayring (2014)

egories after 30% of the material, and (4) coding the remaining material without changing existing categories and adding new categories as needed [549]. After the coding process, the categories were grouped to provide overarching insights into understanding employees' perceptions of the gamified application.

[549]: Mayring (2014)

To examine **RQ4**, a SEM was conducted with utilitarian, hedonic, and social elements as predictors and observed sustainable behavior as the independent variable. Since neither the use of the elements nor the observed sustainable behavior were normally distributed, PLS-SEM in SmartPLS with bootstrapping was again chosen as the analysis method because it is robust [611], but this time standard PLS was chosen instead of consistent PLS because the latent variables are considered formative, i.e., a change in logs as the sole indicator would greatly change the latent variable [615]. Because the items are predicted to have either a positive or no relationship with observed sustained behavior, SEM was performed with a one-tailed significance calculation. To answer **RQ5**, in turn, a consistent PLS-SEM with bootstrapping was performed in SmartPLS due to the reflective nature of the psychological variables. The utilitarian, hedonic, and social elements were included as predictors of the psychological constructs modeled as latent variables. In this case, similar to **RQ2**, effects in both directions could be possible, so a two-tailed significance calculation was chosen.

[611]: Hair *et al.* (2019)

[615]: Sarstedt *et al.* (2016)

Finally, to answer **RQ6** and **RQ7**, the key metrics provided by Companies A, B and C were compared descriptively between the baseline period in the previous year and the field experiment period for each of the companies.

## 12.4 Results

### 12.4.1 Interaction with the Gamified Application

With respect to **RQ1**, descriptive analysis of both total interactions with the gamified application (i.e., event logs) and sustainability actions performed shows that use of the gamified application declines sharply over time (see Figure 12.5). Specifically, 50% (*N = 32,469*) of all interactions with the gamified application were captured in the first week of use, and the first two months accounted for 94.1% (*N = 61,453*) of all interactions with the gamified application. Similarly, 28% of all sustainability actions (*N = 9,761*) were recorded in the first week of use and 93.4% (*N = 32,387*) in the first two months. Although individual interactions and sustainability actions can be observed even after two months, it seems that the appeal of the gamified application is limited to a period of about 60 days, suggesting that some novelty effect [48] influences the motivational effect of the gamified system.

[48]: Koivisto *et al.* (2019)

### 12.4.2 Psychological Outcomes

As prerequisites for the analysis of **RQ2**, the analysis of scale reliability shows that all scales used can be considered reliable with a Cronbach's $\alpha > 0.7$ [618] (see Table 12.3). Also, convergent validity is acceptable for all scales, based on the criterion of composite reliability ≥0.5 [619] and slightly below the threshold of an average extracted variance of ≥0.5 [611]

[618]: McCrae *et al.* (2011)

[619]: Zaiţ *et al.* (2011)

[611]: Hair *et al.* (2019)


Figure 12.5: Interaction with the gamified application during the field experiment.

for perceived behavioral control, pro-environmental attitude, and self-reported sustainable behavior. After careful consideration of item loadings (see Section E.1), item C-PBC3 was excluded because of its low factor loading, which increased the average variance extracted for perceived behavioral control to an acceptable level. The heterotrait-monotrait ratio is below 0.85 for each variable, indicating sufficient discriminant validity [620].

[620]: Henseler *et al.* (2015)

In addition, possible effects of age, gender, or team size on psychological outcomes were investigated with a one-way ANOVA for gender and team size as nominal and ordinal variables, respectively, and with a correlation analysis for age as a metric variable. As a prerequisite for the ANOVAs, Levene's test for variance homogeneity was found to be non-significant for all dependent variables in both analyses, and the Shapiro-Wilk test for normal distribution was significant only for pro-environmental attitude in the case of gender and for pro-environmental attitude, hedonic enjoyment, and self-reported sustainable behavior in the case of team size. Therefore, the non-parametric Kruskal-Wallis test was performed and interpreted in these cases. Analyses reveal no significant relationships between age and any of the variables studied ($-.209 < r < .024$, $p > .05$), nor any influence of gender ($.002 < F < 3.24$, $p > .05$, $\chi^2 = 1.66$, $p > .05$) and team size ($.136 < F < 2.23$, $p > .05$, $0.757 < \chi^2 < 6.339$, $p > .05$) on any of the variables examined.

Descriptive analysis of pretest and posttest values (Table 12.4 and Table 12.5) shows that pro-environmental attitude, subjective norm, perceived behavioral control, hedonic enjoyment and behavioral intention seem to have decreased during the two-month usage period of the gamified app,

Table 12.3: Scale reliability and convergent validity of survey constructs.

| Construct | Pro-environmental attitude | Subjective norm | Perceived behavioral control | Hedonic enjoyment | Perceived environmental knowledge | Behavioral intention | Self-reported sustainable behavior |
|---|---|---|---|---|---|---|---|
| Cronbach's alpha | 0.830 | 0.883 | 0.878 | 0.873 | 0.824 | 0.820 | 0.836 |
| AVE | 0.454 | 0.557 | 0.580 | 0.717 | 0.544 | 0.608 | 0.440 |
| CR | 0.846 | 0.965 | 0.894 | 0.901 | 0.860 | 0.825 | 0.854 |

Table 12.4: Descriptive statistics of survey constructs in pretest and posttest - TPB variables and self-reported sustainable behavior with their sub-scales.

| Construct | Pro-environmental attitude | | Subjective norm | | Perceived behavioral control | | Self-reported sustainable behavior | |
|---|---|---|---|---|---|---|---|---|
| | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest |
| Mean (MD) | 6.30 (6.42) | 6.15 (6.33) | 4.61 (4.67) | 4.57 (4.42) | 4.90 (4.80) | 4.61 (4.80) | 3.56 (3.58) | 3.54 (3.50) |
| | Instrumental attitude | | Injunctive norm | | Capacity | | Task-related PEB | |
| Mean (MD) | 6.67 (7.00) | 6.57 (7.00) | 4.97 (5.00) | 4.99 (5.00) | 5.17 (5.50) | 5.22 (5.50) | 3.72 (3.83) | 3.78 (4.00) |
| | Experiential attitude | | Descriptive norm | | Autonomy | | Proactive PEB | |
| Mean (MD) | 5.94 (6.00) | 5.72 (6.00) | 4.24 (4.33) | 4.15 (4.17) | 4.72 (4.67) | 4.54 (4.67) | 3.40 (3.33) | 3.30 (3.33) |

Table 12.5: Descriptive statistics of survey constructs in pretest and posttest - hedonic enjoyment, perceived environmental knowledge, and behavioral intention.

| Construct | Hedonic enjoyment | | Perceived environmental knowledge | | Behavioral intention | |
|---|---|---|---|---|---|---|
| | Pretest | Posttest | Pretest | Posttest | Pretest | Posttest |
| Mean (MD) | 5.51 (5.67) | 5.46 (5.50) | 5.56 (5.50) | 5.71 (5.75) | 6.08 (6.17) | 5.93 (6.00) |

while perceived environmental knowledge seems to have increased and self-reported sustainable behavior remained fairly constant. Specifically, both instrumental and experiential attitudes decreased, while in terms of subjective norm, only descriptive social norm decreased. Similarly, the capacity dimension of perceived behavioral control actually increased slightly, while the autonomy dimension decreased. Regarding self-reported sustainable behavior, task-related PEB increased slightly, while proactive PEB decreased slightly.

To test whether the observed descriptive differences between pretest and posttest are significant, the precondition of normal distribution for a two-tailed paired t-test was first checked with the Shapiro-Wilk test, which proved to be significant for subjective norm and behavioral intention. Therefore, the non-parametric Wilcoxon signed-rank test must be interpreted in place of Student's t-test for these variables (marked in bold in Table 12.6). The results show little significant difference between the pre- and posttest measurements. As can be seen in Table 12.6, there is no significant difference between pretest and posttest in subjective norm, hedonic enjoyment, perceived environmental knowledge, and self-reported sustainable behavior. However, there is a significant difference in behavioral intention ($d = 0.257$, $p = .013$), perceived behavioral control ($d = 0.293$, $p = .039$), and pro-environmental attitude ($d = 0.303$, $p = .034$) between pretest and posttest, suggesting that the decrease observed in the descriptive statistics is significant.

With respect to the trajectory toward sustainable behavior, the SEM results are interpreted both in terms of the path coefficients ($\beta$), their significance (p), and, because significance is calculated based on standard errors, which can be a problematic basis for highly skewed distributions [621], effect sizes ($f^2$). Figure 12.6 shows that pro-environmental attitude largely ($f^2 \geq 0.35$, [622]) and perceived environmental knowledge and hedonic enjoyment moderately ($f^2 \geq 0.15$, [622]) and significantly influence behavioral intention, supporting the assumptions of goal-framing theory [133]. In addition, perceived behavioral control has a small significant effect on

[621]: Hair *et al.* (2014)

[622]: Cohen (1988)

[133]: Lindenberg *et al.* (2013)

Table 12.6: Results of two-tailed paired t-test (test statistic to be interpreted based on Shapiro-Wilk test for normal distribution marked in bold, significant results marked with an asterisk).

| Construct | Test | Statistic | df | p |
|---|---|---|---|---|
| Pro-environmental attitude | **Student's t** | **2.181** | **51.0** | **0.034*** |
| | Wilcoxon W | 519 | | 0.031 |
| Subjective norm | Student's t | 0.399 | 51.0 | 0.692 |
| | **Wilcoxon W** | **562** | | **0.818** |
| Perceived behavioral control | **Student's t** | **2.11** | **51.0** | **0.039*** |
| | Wilcoxon W | 652 | | 0.515 |
| Hedonic enjoyment | **Student's t** | **0.533** | **51.0** | **0.596** |
| | Wilcoxon W | 490 | | 0.633 |
| Perceived environmental knowledge | **Student's t** | **-1635** | **51.0** | **0.108** |
| | Wilcoxon W | 308 | | 0.167 |
| Behavioral intention | Student's t | 1851 | 51.0 | 0.070 |
| | **Wilcoxon W** | **541** | | **0.013*** |
| Self-reported sustainable behavior | **Student's t** | **0.250** | **51.0** | **0.804** |
| | Wilcoxon W | 602 | | 0.921 |

behavioral intention (*$f^2 \geq 0.02$*, [622]), and behavioral intention significantly and moderately (*$f^2 \geq 0.15$*, [622]) influences self-reported sustainable behavior, supporting previous findings in the field of sustainable employee behavior based on the TPB [166]. Overall, the model explains 83% of the variance in the endogenous variable behavioral intention (*$R^2 = 0.830$*) and 21.2% of the variance in self-reported sustainable behavior (*$R^2 = 0.212$*).

[622]: Cohen (1988)

[166]: Ajzen (1991)

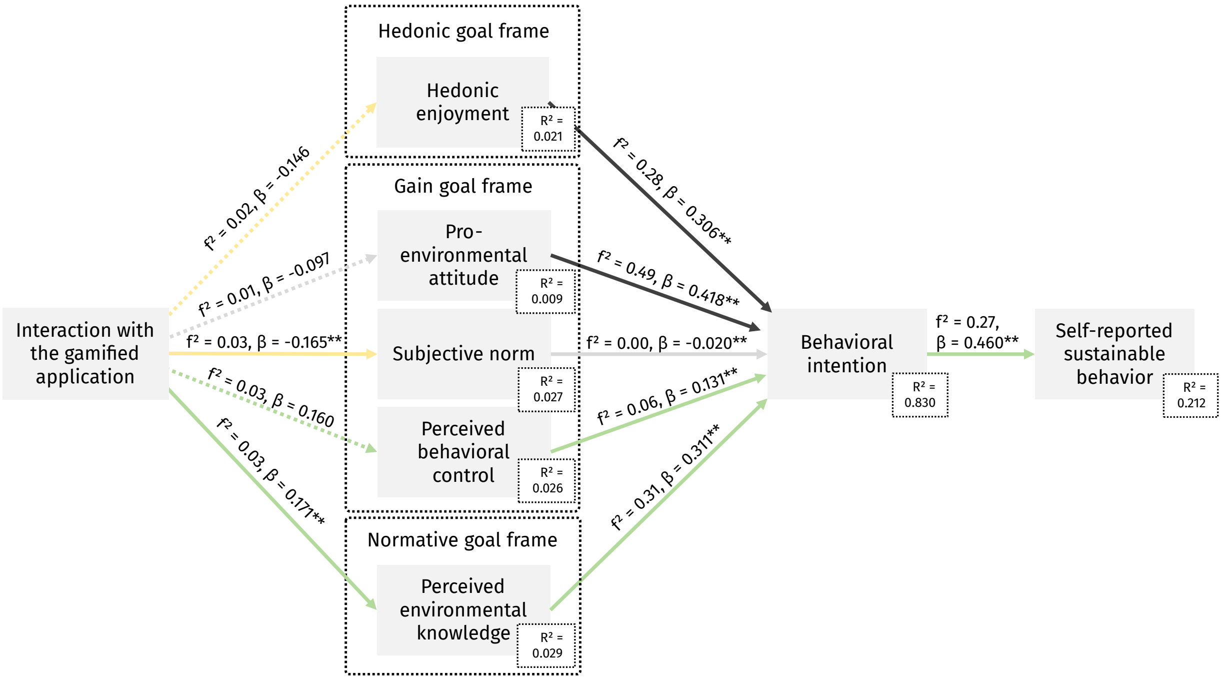


Figure 12.6: SEM results for the influence of using the gamified application on psychological determinants and self-reported sustainable behavior (dotted (n.s.) versus straight (s.) lines illustrate significance, light gray illustrates no effect ($f^2 < 0.02$), dark grey lines illustrate at least small effects ($f^2 \geq 0.02$), green lines illustrate pathways to sustainable behavior, and yellow lines illustrate at least small negative effects ($f^2 \geq 0.02$)).

Considering the interaction with the gamified application as a predictor variable, it generally has low explanatory power for the psychological variables (*$0.009 < R^2 < 0.026$*), but it does reveal a possible path to sustainable employee behavior across both the normative and gain goal frames (highlighted in green). Specifically, interaction with the gamified application has

**Table 12.7:** Supportive aspects of the gamified application experienced by employees.

| Supportive aspect | Employees noting the aspect |
|---|---|
| **Learning about sustainable behavior** | |
| Receiving new ideas for sustainable behavior at work | P6, P9, P11, P12, P14, P17, P22, P32, P37, P40, P43, P46, P49, P50 |
| Learning about the effects of sustainable behavior at work | P4, P14, P20, P24, P32, P42 |
| Unlocking new actions over time | P11, P25, P41, P49 |
| Breaking down sustainable behavior into goals and tasks | P26, P33, P37, P52 |
| **Social motivation for sustainable behavior** | |
| Enabling comparison with colleagues | P1, P12, P15, P21, P28, P34, P38, P40, P43, P44, P47 |
| Encouraging collaborative efforts with colleagues | P27, P34, P36, P41, P45 |
| **Positive reinforcement for sustainable behavior** | |
| Allowing for progress tracking and monitoring | P1, P6, P8, P10, P14, P16, P32, P48, P49 |
| Receiving badges for achievements | P6, P12, P44 |
| Receiving positive feedback for sustainable behavior | P38, P40 |
| **Consistent reminding of sustainable behavior** | P11, P13, P17, P27, P29, P33, P40, P41, P43, P44, P47 |

both a small, significant effect on perceived environmental knowledge ($f^2 \geq 0.02$, [622]) and a small but nonsignificant effect on perceived behavioral control ($f^2 \geq 0.02$, [622]). However, it is surprising and in need of discussion why the interaction with the gamified application also has a small negative effect on subjective norm as well as hedonic enjoyment, although this is consistent with the descriptive observation that attitude and hedonic enjoyment decreased from pretest to posttest.

[622]: Cohen (1988)

Conclusively, while the results largely support theoretical assumptions of goal-framing theory [133] and TPB [166], the use of the gamified application appears to have little impact on antecedents and self-reported sustainable employee behavior, aside from the visible pathway through perceived environmental knowledge and a possible pathway through perceived behavioral control. This suggests that the gamified application mainly impacts learning and self-efficacy rather than hedonic experience related to sustainable behavior (**RQ2**).

[133]: Lindenberg *et al.* (2013)

[166]: Ajzen (1991)

With regard to the subjective experiences of the employees (**RQ3**), the analysis of the qualitative statements supports the results of the quantitative analysis. Specifically, employees cited a variety of supportive aspects of the gamified application (Table 12.7) related to learning and positive reinforcement for sustainable behavior at work.

In particular, about a quarter of all employees reported that they received new ideas for sustainable behavior at work in the two-month period that they *"have already internalized"* (P14).

> *"Especially since you also come across little things that you haven't paid attention to so far and then just start doing it (e.g. at least turn off the screen when I'm doing something else for a few minutes). Simply because one does not necessarily think about the fact that 'a penny saved is a penny got'" (P32).*

Some also reported learning about the effects of their own sustainable behaviors at work (P4, P14, P20, P24, P32, P42), and four employees particularly liked that they were able to unlock new ideas for sustainability over time (P11, P25, P41, P49).

Second, employees found that the gamified application activated social motivations for sustainable behavior. While social comparison with colleagues was mentioned more often than collaboration, some colleagues also noted that they valued collaborative efforts with colleagues enabled by the gamified application (P27, P34, P36, P41, P45). In particular, P14 expressed that this collaboration visibly translated into changed behavior in the workplace:

> *"And when I see how my colleagues act in a sustainable manner, I am pleased and motivated" (P14).*

Third, employees mentioned that both progress tracking and monitoring (P1, P6, P8, P10, P14, P16, P32, P48, P49), especially with points, but also badges (P6, P12, P44) and positive feedback (P38, P40) motivated them to engage in sustainable behaviors because they were a form of positive reinforcement that made sustainable behavior fun:

> *"Completing actions and earning the points associated with them was fun" (P8).*

Finally, employees also appreciated that the gamified app constantly reminded them to engage in sustainable behaviors through notifications, especially tips (P17, P40, P41), but also general reminders to record actions in the app at the end of the workday (P33, P43).

On the other hand, employees also noted obstructive experiences with the gamified application that hindered engagement in sustainable behavior (Table 12.8).

One of the most frequently cited reasons for declining use of the gamified application and thus for a lack of long-term effects was logging fatigue. Almost a quarter of employees said they felt it was *"too much effort to log everything in the app"* (P7), which was particularly amplified when employees also experienced no learning effect:

> *"Always recording that I have turned off the tap while washing my hands [...], it's too much for me in the long run. Especially with topics that I have already done before" (P35).*

It turns out that while several employees mentioned learning effects of the gamified application, especially those who were already strongly engaged in sustainability before did not see any learning benefits, saying that *"too many tasks were obvious and already integrated into [their] daily routine"* (P26) and that there were *"hardly any actions that [they] don't already do in everyday life anyway"* (P28).

Some employees also pointed to a novelty effect, i.e., although they initially found the gamified application and its content exciting and interesting, the learning effects diminished over time and it became boring:

Table 12.8: Obstructive aspects of the gamified application experienced by employees.

| Obstructive aspect | Employees noting the aspect |
|---|---|
| **Logging fatigue** | **P3, P6, P7, P14, P15, P17, P21, P27, P35, P36, P41, P46** |
| **Absence of learning effects** | **P3, P4, P5, P7, P17, P26, P28, P36, P42, P48** |
| **Novelty effect** | |
| Boredom after some time | P32, P33, P34, P41, P48 |
| Decrease of learning effects over time | P11, P51 |
| **Interference from the work environment** | |
| Missing time in daily work | P13, P16, P24, P48, P49 |
| Oblivion during daily work | P14, P41 |
| **Missing individual relevance** | |
| Suggestions not suitable for individual circumstances | P14, P32, P37 |
| Lack of individualization | P5 |
| **Obstacles in usability and design** | **P4, P5, P12, P30, P32, P34, P36, P37, P51** |
| **Intrusive behavior** | **P17, P29, P31, P38, P47, P51** |
| **Lack of critical mass** | **P6, P7, P21, P28, P39** |
| **Personal circumstances** | **P8, P10, P12, P50** |

*"With time, you know all the points, or I noticed that I do a lot of things anyway and then the incentive to use the app is of course not so high" (P48).*

In addition, employees mentioned interferences from the work environment, such as lack of time in their daily work (P13, P16, P24, P48, P49) and forgetting to use the application (P14, P41) as hindering factors, as well as sometimes not being able to perform the suggested actions in the gamified application due to individual circumstances (P14, P32, P37).

In this context, some employees also perceived the gamified application as too intrusive, especially with its regular notifications, and therefore refused to continue using it (P17, P29, P31, P38, P47, P51), or encountered general usability and design obstacles that demotivated the use of the application (P4, P5, P12, P30, P32, P34, P36, P37, P51).

Finally, it is particularly noteworthy that five employees (P6, P7, P21, P28, P39) stated that they would have *"thought it would be cool to have a little "competition" with [their] colleagues"* (P39), but that there was a lack of a critical mass of colleagues also using the application, and therefore their own motivation to behave in a sustainable manner decreased:

*"I see that many colleagues have almost identical scores for several days. This mirrors my behavior towards the app" (P21).*

In summary, employees cited several supportive aspects of the gamified application, particularly related to learning, positive reinforcement through progress monitoring and feedback, and social motivation through social comparison and collaborative efforts, which may help explain the positive effect of interacting with the gamified application on perceived environmental knowledge and perceived behavioral control, i.e., self-efficacy [352], in sustainable behavior. On the other hand, the obstructive aspects of using the gamified application mentioned by the employees may help explain some of the negative effects observed in the quantitative results,

[352]: Bandura (1982)

e.g., hedonic enjoyment may be negatively affected by prolonged use of the gamified application due to logging fatigue and novelty effect, and the observation of a lack of peer engagement may have contributed to the negative effects on subjective norm.

### 12.4.3 Behavioral Outcomes

**Publication of this section.**

Parts of this section, although based on different data, were similarly worded in [95] J. Krath, B. Morschheuser, H. F. O. von Korflesch, and J. Hamari, "How to increase sustainable engagement in the workplace through green IS: the role of instructional and motivational design features", in Thirty-first European Conference on Information Systems (ECIS 2023), Kristiansand, Norway, Jun. 2023, p. 244, https://aisel.aisnet.org/ecis2023_rp/244/.

For behavioral outcomes (**RQ4, RQ5**), the logs of the 247 employees who performed at least one sustainability action were first limited for each participant to the relevant two-month period since registration, during which most of the activities took place (**RQ1**) and which corresponds to the period between the two surveys (**RQ2**). In this way, the final set of logs consisted of 31,705 logs related to the use of the main utilitarian, hedonic, and social elements of the gamified application, and 32,387 actions as observed sustainable behaviors.

Table 12.9 shows the descriptive statistics for the main utilitarian, hedonic, and social elements, as well as for the observed sustainable behavior. It is important to note that two of the user stories implemented in the gamified application were not captured by the logs: First, the juicy feedback animations (**US2**) were only displayed but did not allow for any specific interaction that could have differed between users, so there was no log to capture responses to the feedback animations. And second, although the functionality to provide company-wide goals with tangible company rewards was implemented in the gamified application (**US21**), none of the participating companies agreed to provide tangible incentives, so the feature could not be used by any of the employees.

**The Python Fitter Library.**

The Python Fitter package allows the inspection of data against 80 distributions and provides fit measures such as the Bayesian Information Criterion to decide which distribution best fits the data: https://pypi.org/project/fitter/.

In general, utilitarian elements have been used most by employees, followed by hedonic elements and social elements. The differences between means and medians and the high standard derivations indicate a rather uneven distribution with high skewness for all three types of elements and observed sustainable behavior. Using the Python Fitter library on the distributions, the Bayesian Information Criterion [623] shows that the distributions are best described as lognormal, which is consistent with common usage patterns of participation inequality that 90% of users of online services show very low engagement, 9% are frequently engaged and 1% of users are responsible for most of the activities and content [624], [625].

[623]: Schwarz (1978)
[624]: Nielsen (2006)
[625]: Sun *et al.* (2014)

Specifically, for the utilitarian elements, employees used the progress-related features, including their own profile with progress bars and point distribution in different categories, and tracking goal progress (**US3-US5**) most frequently, followed by goal setting. For hedonic elements, employees mostly used functions related to freedom of choice and exploration (**US18**), i.e., exploring all sustainability actions and their details, and rolling the dice on actions. Regarding social elements, employees mainly used competitive features (**US12**), i.e., ranking and competitions, while they were less engaged with other users' profiles or team building and team goals.

Due to the lognormal distribution, descriptive statistics alone are hardly useful when it comes to the usage patterns of the main users, i.e., those in the tail who use the app over a long period of time [626]. Thus, following previous research on technology adoption [627], the Complementary Cumulative Distribution Function (CCDF), commonly known as "survival

[626]: Alstott *et al.* (2014)
[627]: Coeurderoy *et al.* (2014)

**Table 12.9:** Descriptive statistics of utilitarian, hedonic and social elements in the gamified application.

| Element | Mean | MD | Sum | SD | Min | Max |
|---|---|---|---|---|---|---|
| **Utilitarian elements** | 53.3 | 27 | 13,163 | 80.3 | 0 | 736 |
| Goal setting (US1) | 8.10 | 4 | 2,001 | 14.3 | 0 | 159 |
| Progress (US3-US5) | 13.5 | 7 | 3,337 | 20.7 | 0 | 210 |
| Rewards (badges) (US6) | 5.14 | 1 | 1,296 | 21.5 | 0 | 292 |
| Impact (US7) | 5.59 | 1 | 1,381 | 12.3 | 0 | 92 |
| Reminders (US8) | 6.68 | 3 | 1,650 | 11 | 0 | 84 |
| Onboarding (US19) | 0.13 | 0 | 32 | 0.45 | 0 | 3 |
| Action history (US24) | 3.98 | 2 | 984 | 5.66 | 0 | 36 |
| Easy tracking (US20) | 4.45 | 0 | 1,098 | 10.8 | 0 | 70 |
| Tips (US10) | 0.73 | 0 | 180 | 1.82 | 0 | 14 |
| Guidance (US9) | 4.98 | 2 | 1,231 | 14.8 | 0 | 202 |
| **Hedonic elements** | 42.8 | 26 | 10,570 | 51.5 | 0 | 470 |
| Settings (US15) | 5.3 | 2 | 1,308 | 12.3 | 0 | 162 |
| Unlockable and new content (US16, US17) | 4.35 | 2 | 1,074 | 6.76 | 0 | 61 |
| Motivational messages (US23) | 0.72 | 0 | 178 | 1.8 | 0 | 14 |
| Freedom of choice (US18) | 32.4 | 18 | 8,010 | 37.8 | 0 | 255 |
| **Social elements** | 32.3 | 12 | 7,972 | 53.8 | 0 | 419 |
| Peer profiles (US11) | 6.03 | 1 | 1490 | 11.8 | 0 | 90 |
| Teams (US13) | 6 | 1 | 1483 | 15.2 | 0 | 133 |
| Customization (US14) | 1.75 | 1 | 432 | 2.98 | 0 | 31 |
| Competition (US12) | 18.5 | 7 | 4567 | 31.4 | 0 | 284 |
| **Observed sustainable behavior** | 131 | 43.0 | 32,387 | 253 | 1 | 1,710 |

functions" [628], of utilitarian, hedonic, and social elements are considered and their log-log plot analyzed, where the x-axis represents the number of logs of elements per user and the y-axis ($P(X \geq x)$) represents the probability that an employee uses an element at least x times (see Figure 12.7). The Powerlaw for Python library [626] is used to plot the CCDF. The CCDF show that at the end of the distribution, i.e., with highly engaged employees, social elements gain importance and are used more than by the mass of users, but most importantly, utilitarian elements are used much more than both hedonic and social elements. The visible difference from the pattern of most users for social elements occurs at 110 logs of social elements, representing the 95th percentile, and for utilitarian elements at 250 logs of utilitarian elements, representing the 98th percentile. The CCDF thus suggests that for the top 5% of users, i.e., those who engage frequently [624], [625], social elements appear to be more important than for the majority of users, and for the top 2% of users, i.e., those who are responsible for most i.e., activity [624], [625] (and who account for 5,659 of 32,387, or 17.5% of all actions), utilitarian elements appear to be more important than for the mass of users.

[628]: Bégin *et al.* (2018)

[626]: Alstott *et al.* (2014)

[624]: Nielsen (2006)
[625]: Sun *et al.* (2014)

With respect to **RQ4**, the results of the SEM (Figure 12.8) show that the use of hedonic elements significantly influences observed sustainable behavior with a medium effect ($f^2 \geq 0.15$, [622], whereas social elements have a small influence ($f^2 \geq 0.02$, [622]) that is on the edge of significance ($p = .055$). Utilitarian elements, on the other hand, have a very small and non-significant influence on observed sustainable behavior. Overall, the model explains 57.3% of the variance in observed sustained behavior ($R^2 = .573$).

[622]: Cohen (1988)

For **RQ5**, only the subset of logs from the 52 employees who also completed both surveys is used as the basis for analysis, yielding a total of 10,716

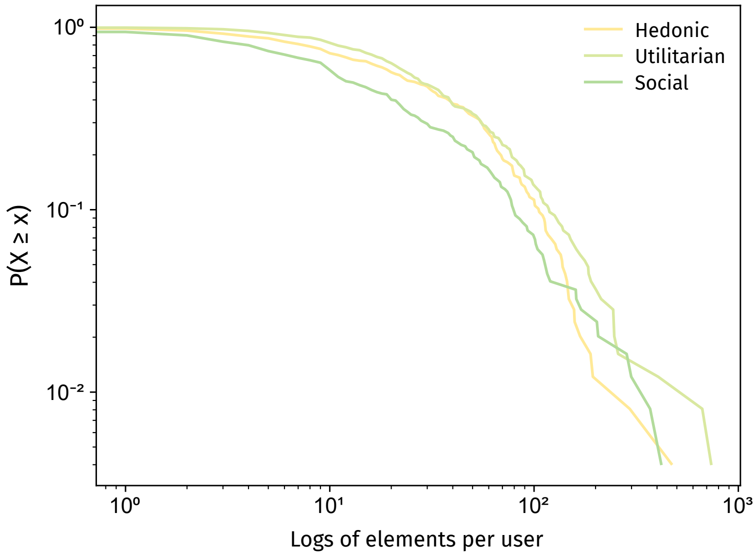


**Figure 12.7:** CCDF of utilitarian, hedonic and social elements in the gamified application. The x-axis represents the number of logs of elements per user and the y-axis ($P(X \geq x)$) represents the probability that an employee uses an element at least x times.

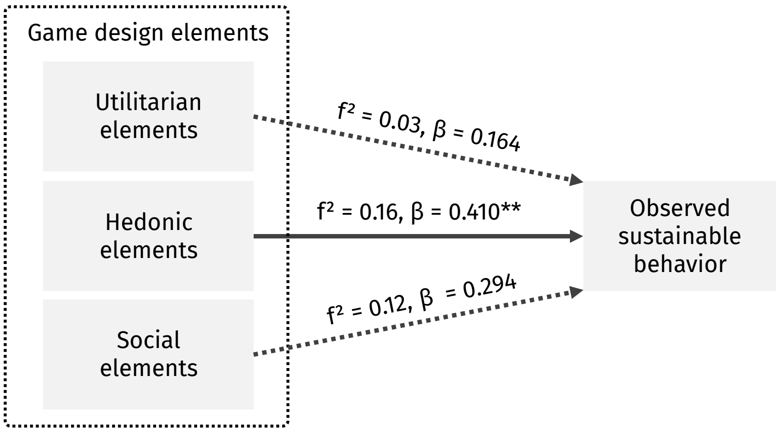


**Figure 12.8:** SEM results for the influence of different game design elements on observed sustainable behavior (dotted (n.s.) versus straight (s.) lines illustrate significance, dark grey lines illustrate at least small effects ($f^2 \geq 0.02$)).

logs on utilitarian ($N = 4{,}631$), hedonic ($N = 3{,}319$), and social ($N = 2{,}766$) elements.

The SEM results show that the use of utilitarian elements has a small significant positive effect on perceived environmental knowledge ($f^2 \geq 0.02$, [622]) and a small but non-significant positive effect on perceived behavioral control and pro-environmental attitude ($f^2 \geq 0.02$, [622]), whereas social elements have a small ($f^2 \geq 0.02$, [622]) significant positive effect on subjective norm. Interestingly, the use of hedonic elements has a negative effect on psychological outcomes, in particular, there is a small negative and significant effect on hedonic enjoyment and subjective norm. In addition, there is a small ($f^2 \geq 0.02$, [622]) but non-significant negative effect of social elements on pro-environmental attitude and perceived behavioral control. The explanatory power of gamification increases in contrast to interaction in general ($0.045 < R^2 < 0.189$). Overall, the path coefficients and effect sizes of the psychological determinants on self-reported sustainable behavior change slightly with the addition of the various gamification design elements compared to the interaction in general, but the explanatory power ($R^2 = 0.826$ for behavioral intention and $R^2 = 0.212$ for self-reported sustainable behavior) and trajectory remain similar: as before, sustainable behavior is influenced by gamification via behavioral intention and perceived behavioral control as well as perceived environmental knowl-

[622]: Cohen (1988)

edge. However, the new finding is that mainly utilitarian elements are responsible for this pathway and that those can additionally influence behavioral intention via pro-environmental attitude, while the influence of hedonic and social elements on sustainable employee behavior remains questionable.

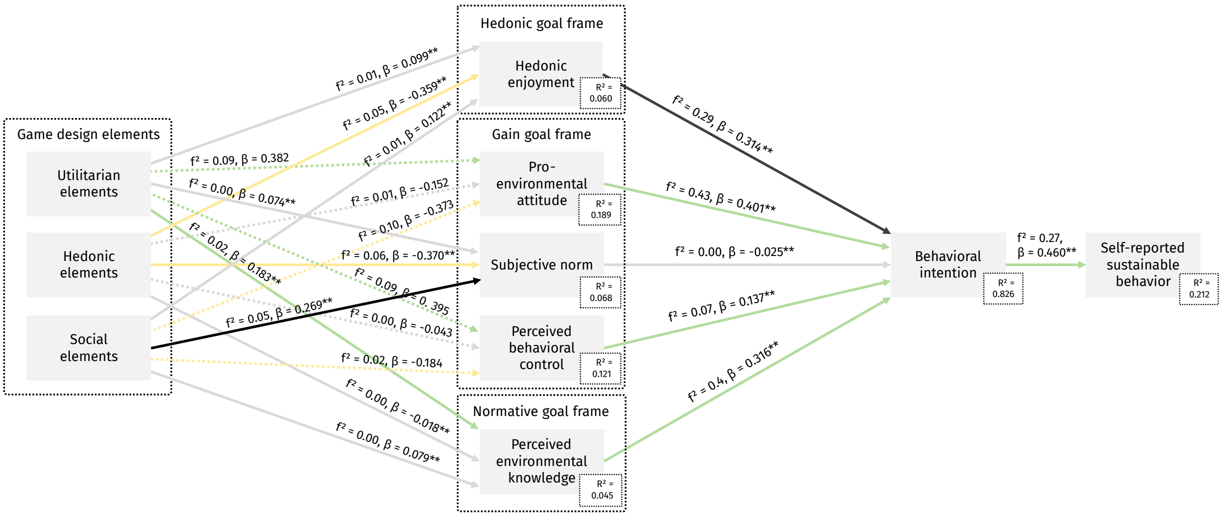


**Figure 12.9:** SEM results for the influence of different game design elements on psychological determinants and self-reported sustainable behavior (dotted (n.s.) versus straight (s.) lines illustrate significance, light gray illustrates no effect ($f^2 < 0.02$), dark grey lines illustrates at least small effects ($f^2 \geq 0.02$), green lines illustrate pathways to sustainable behavior, and yellow lines illustrate at least small negative effects ($f^2 \geq 0.02$)).

In summary, the different game design elements influence both observed sustainable behavior and the antecedents of self-reported sustainable behavior, but not in the same way. This is particularly interesting given that observed sustainable behavior and self-reported sustainable behavior are not correlated (*r = 0.043, p = 0.38*). Specifically, the results suggest that the use of hedonic elements has a particular impact on how many sustainability actions employees log within the gamified application, but this does not translate into positive psychological outcomes. Rather, hedonic elements actually have a negative impact on hedonic enjoyment of sustainable behavior and subjective norm. In contrast, while not particularly predictive of logging sustainability actions, the use of utilitarian elements supports perceived environmental knowledge, pro-environmental attitude and perceived behavioral control, and social elements appear to lead to both logging actions within the gamified application (though not significantly) and increasing subjective norm (though this does not affect behavioral intention).

## 12.4.4 Corporate Outcomes

Finally, in terms of corporate outcomes (**RQ6, RQ7**), the results are largely mixed, suggesting potential impacts of the gamified application on corporate sustainability in some, but not all, dimensions of sustainable behavior. Due to the declining use of the gamified intervention (Figure 12.5), only the first two months of the intervention, i.e., September and October 2022 among those companies that provided key sustainability metrics, are considered for the analysis of potential effects induced by its use.

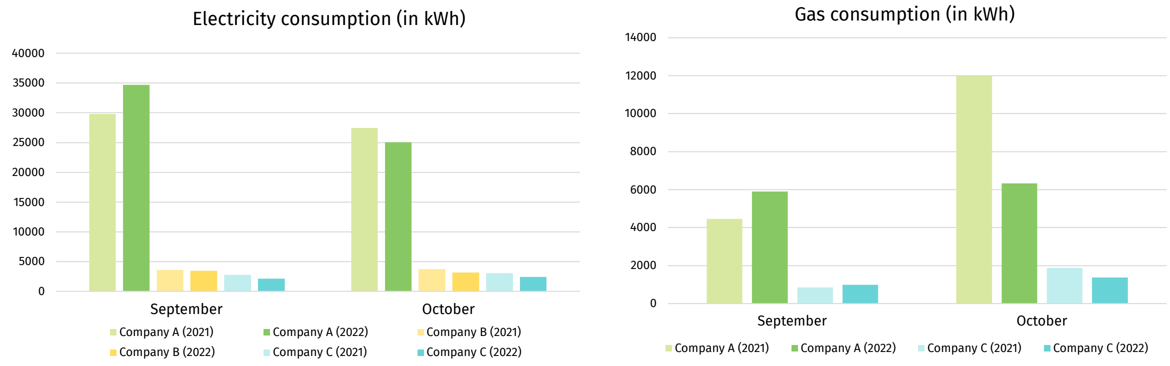


**Figure 12.10:** Electricity and gas consumption in the companies during the base and intervention periods.

In terms of energy consumption (SDG 7), i.e., electricity and gas consumption (Figure 12.10), the comparison between the baseline and experiment periods shows that there was no particular effect of the gamified application on gas consumption. Rather, gas consumption actually increased in September for both Company A and Company C compared to the baseline period, while it decreased sharply in October. However, given the usage patterns of the gamified application (Figure 12.5), it is likely that this effect cannot be attributed to the gamified application. Rather, other factors such as the energy crisis in Germany in the fall of 2022, where society was asked to conserve gas due to the destruction of the Nord Stream gas pipeline [629], or unconventional warm days in October [630] may have had a major impact on gas consumption. In the case of electricity consumption, the impact of the gamified application varies greatly by company. While the results for Company A show similar patterns to gas consumption (i.e., an increase in September and a decrease, albeit much smaller, in October), electricity consumption in Company B and Company C buildings decreased substantially during the field experiment. Company B saved 172.78 kWh of electricity in September and 589.32 kWh in October, a reduction of 4.76% and 15.76%, respectively, compared to the baseline period. Company C saved even more electricity, 669.7 kWh in September and 642.83 kWh in October, which corresponds to a reduction of 24% and 20.9%, respectively, compared to the baseline period.

[629]: Nord Stream (2022)

[630]: Deutscher Wetterdienst (2022)

Regarding CO2 emissions from transport (SDG 11), only Company A provided data on CO2 emissions from both its vehicle fleet (calculated using kilometers driven by employees in company vehicles) and business travel (calculated using modes of transport and total kilometers driven). Figure 12.11 shows that there is no particular pattern that might indicate effects of gamified application, with CO2 emissions from the vehicle fleet decreasing slightly in September but increasing in October, and CO2 emissions from business travel largely increasing in September and largely decreasing in October, compared to the baseline period.

For water consumption (SDG 6), both Company A and Company C do not show consistent patterns (see Figure 12.12). For Company A, water consumption decreased in September but increased in October compared to the baseline period, and for Company C, water consumption remained the same in September and decreased slightly in October.

Finally, with regard to waste and recycling (SDG 12), there are notable decreases in both paper usage at Company C (Figure 12.12) and residual

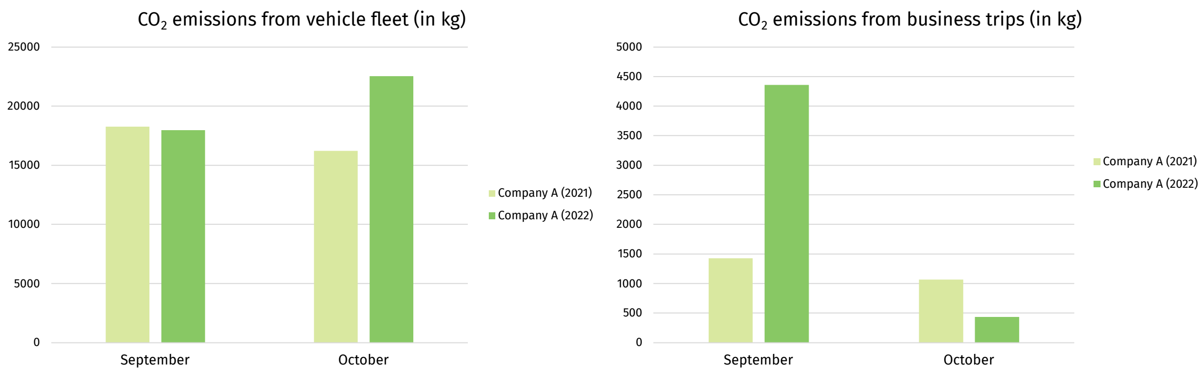


Figure 12.11: CO2 emissions in company A during the base and intervention periods.

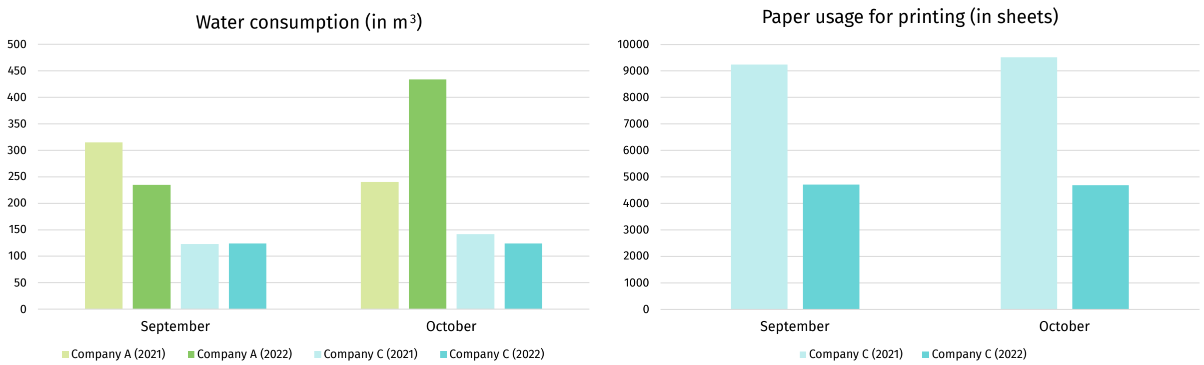


Figure 12.12: Water consumption and paper usage in the companies during the base and intervention periods.

waste at Company B (Figure 12.13). Paper use for printing in Company C decreased sharply in both September and October, with savings of 4,532 sheets of paper in September and 4,836 sheets of paper in October, representing savings of 49.1% and 50.8%, respectively, compared to the baseline period. Waste production in Company B also saw a large decrease in the amount of residual waste during the field experiment period, with 135l (34.6% compared to the baseline) of residual waste saved in September and 180l (43.9% compared to the baseline) in October. At the same time, paper waste increased from 209l in September 2021 to 410l in September 2022 and from 121l in October 2021 to 395l in October 2022. Although recycling waste (i.e., plastics) did not show a similar pattern in October (but also increased in September), the results suggest a shift from disposing of paper and plastics in residual waste to proper recycling thanks to the gamified application.

In summary, there appears to be a large difference in general between companies with high participation rates (Company B, Company C with more than half of all employees participating) and those with low participation rates (Company A, with a participation rate of 9,75%) in terms of the impact of the gamified application on corporate sustainability metrics (**RQ7**). In addition, electricity consumption (SDG 7) and waste production (SDG 12) seem to be more affected by the gamified application than gas consumption (SDG 7), business travel (SDG 11) and water consumption (SDG 6) (**RQ6**). This suggests that the gamified application was either not motivating enough for these sustainability dimensions or that they are influenced to a greater extent by external influences such as the number of employees in the office, the weather and energy crisis, or business operations and needs.


Figure 12.13: Waste production in company B during the base and intervention periods.

## 12.5 Discussion

Previous research has provided valuable insights into gamification for sustainable employee behavior in the workplace, demonstrating a variety of positive psychological and behavioral outcomes from gamified interventions, such as for employee health and well-being [304], [306], energy-saving behavior [82], and creative ideas for innovation [75], [362]. Nevertheless, previous studies have not been able to fully understand how gamification, and in particular different elements of game design, influence the psychological trajectory of behavioral outcomes and how this translates into corporate sustainability at multiple dimensions. This study contributes to a deeper understanding of the psychological and behavioral outcomes of different gamification design aspects by building on a theoretical framework of goal-framing theory [133] and the TPB [166] and triangulating quantitative and qualitative survey data with behavioral logs and corporate metrics to reveal critical pathways to sustainable employee behavior in organizations.

[304]: Newcomb *et al.* (2019)
[306]: Jackson *et al.* (2020)
[82]: Lou *et al.* (2019)
[75]: Patricio *et al.* (2020)
[362]: Nivedhitha (2022)
[133]: Lindenberg *et al.* (2013)
[166]: Ajzen (1991)

Four key learnings can be derived from the results that extend previous knowledge and contribute to shaping future research on gamification for sustainable employee behavior in the workplace.

First, *there is solid evidence of a novelty effect in the use of gamification for sustainable employee behavior*. While previous research on gamification has called for attention to potential novelty effects [48], [631] that may not only lead to a decline in engagement but also prevent lasting behavior change [632], little research on gamification for sustainable employee behavior in the environmental dimension, which mostly examined short periods of use [82], [84], [87], has considered whether its effects might be attributed solely to a novelty effect. Analysis of employee engagement with the gamified application combined with qualitative findings on boredom and logging fatigue over time clearly shows that gamified interventions suffer from a novelty effect, with the greatest engagement in the first week and virtually no interaction with the gamified application after two months. This finding indicates that the novelty effect can confound the results of short-term interventions and underscores the need for studies that use long-term interventions to examine gamification outcomes in any application domain [48].

[48]: Koivisto *et al.* (2019)
[631]: Rodrigues *et al.* (2022)
[632]: Sanchez *et al.* (2020)
[84]: Oppong-Tawiah *et al.* (2020)
[87]: Wunsch *et al.* (2016)

However, it must be kept in mind that 90% of users who show very low engagement with a system are fairly normal [624], [625], and that the

[624]: Nielsen (2006)
[625]: Sun *et al.* (2014)

focus should be placed on how gamification influences psychological determinants and sustainable behavior even in the comparatively short time frame of use. This leads to the second key learning: *interaction with gamification activates gain and normative goal frames, which in turn shape behavioral intentions and lead to changes in self-reported sustainable behavior*.

Specifically, the descriptive results show that across all employees, there was a notable (though not significant, which could be due to the small sample size of employees completing both surveys) increase in perceived environmental knowledge between the pretest and posttest, even considering that perceived environmental knowledge was already quite high in the pretest, suggesting a possible learning effect and supporting previous studies that have demonstrated learning gains from gamification for sustainable employee behavior [68], [78], [315]. Examining how interaction with the gamified application affects psychological trajectories towards sustainable behavior shows that the amount of interaction particularly affects perceived environmental knowledge (normative goal frame) and perceived behavioral control (gain goal frame), which then influence behavioral intention and self-reported sustainable behavior. This is particularly insightful given that previous studies have focused primarily on the psychological outcomes of gamification at the hedonic plane [79], [82], [84], [316], [319], [320].

[68]: Dadaczynski *et al.* (2017)
[78]: Hafer *et al.* (2017)
[315]: Hart *et al.* (2020)

[79]: Kaselofsky *et al.* (2020)
[82]: Lou *et al.* (2019)
[84]: Oppong-Tawiah *et al.* (2020)
[316]: Omiya *et al.* (2019)
[319]: Barna *et al.* (2018)
[320]: Gremaud *et al.* (2018)

[249]: Hamari *et al.* (2015)

[47]: Hillebrand *et al.* (2021)
[289]: Ro *et al.* (2017)
[633]: Seidler *et al.* (2020)

In particular, detailed analysis of the effects of different utilitarian, hedonic, and social design elements based on the general aspects of user experience in motivational IS [249] shows that different elements of game design do indeed have different impacts on psychological outcomes, which sheds new light on previous research that has mostly looked at the effects of design elements as a whole rather than individually [47], [289], [633]. The findings show that utilitarian elements, such as goal setting and guidance to achieve these goals, progress monitoring, and reminders, have positive effects on perceived environmental knowledge, pro-environmental attitude and perceived behavioral control. This finding is supported by qualitative evidence highlighting the learning experience and positive reinforcement of one's performance as supportive aspects of gamified application, which may explain especially why the capacity dimension of perceived behavioral control increased from the pretest phase to the posttest. Also, the observation that the most engaged users used considerably more utilitarian elements than the mass of users underscores the perceived benefits of utilitarian elements. Moreover, social elements activate the subjective norm dimension of the gain goal frame, i.e., they reinforce the belief that peers expect sustainable behavior through social comparison and collaborative efforts.

However, the study also reveals negative effects of gamification, which points to the third key learning: *gamification can have counterproductive effects on employees who are already striving for sustainable behavior*.

Although the finding that interaction with the gamified application in general, and interaction with hedonic elements in particular, has a negative effect on hedonic enjoyment of sustainable behavior and subjective norm initially seems to contradict previous studies that found large positive effects on enjoyment (e.g. [316], [319], [320]), these results paint a coherent picture when user behavior and qualitative results are considered. On the one hand, interaction with hedonic elements, specifically exploration of different actions for sustainability, significantly predicts observed sustainable behavior, i.e., the number of logged actions within the gamified application, while interaction with utilitarian elements, i.e., goal setting, suggestions for actions that contribute to the goal (guidance), tips, and reminders, does not predict observed sustainable behavior. On the other hand, the qualitative results imply that a number of employees experienced logging fatigue, especially when combined with a lack of learning effects, i.e., they reported that they did not learn anything new about sustainable behavior, but only recorded what they were already doing until they found it too much effort.

This suggests that employees who already know a lot about sustainable behavior and are already engaged rarely use goal setting and guidance, but rather the gamified application makes them just look at what actions they can check off based on their regular behavior. For these people, it may be demotivating to see in the gamified application that their peers struggle much more with sustainable behavior and log fewer actions, which in particular lowers the descriptive subjective norm (i.e., how others' behavior is perceived [604]). Moreover, it might explain why the hedonic elements intended to evoke feelings of autonomy, exploration, or surprise [249], by providing freedom of choice for sustainable behavior and unlocking new actions over time, caused opposite effects on hedonic enjoyment of sustainable behavior: Those employees who were particularly committed to sustainable behavior and therefore explored and logged many actions may have felt disappointed by the transparency of their colleagues' lack of dedication, causing them to feel less enjoyment in sustainable behavior themselves.

[604]: Ajzen *et al.* (2010)

[249]: Hamari *et al.* (2015)

Finally, analysis of company metrics reveals a fourth important learning: *gamification can support corporate sustainability outcomes if participation rates are sufficient.*

While previous research has focused primarily on energy conservation [78], [79], [82], [86] and ideation [75]–[77], [313] as corporate outcomes of sustainable employee behavior, this study shows that gamification can lead to remarkable corporate outcomes in various sustainability dimensions, especially energy conservation, paper use, and recycling, even in the short time frame of use. However, these effects depend mainly on the participation rate of employees rather than the total number of participants: it is in smaller companies that the effects are greatest. The results also suggest that some dimensions of sustainability are more easily influenced by interventions for sustainable employee behavior than others: While gamification is able to motivate energy conservation and raise awareness of recycling, metrics such as gas and water consumption may be much more influenced by external factors such as weather [630], the energy crisis caused by the North Stream pipeline leak [629] or the number of employees working from home due to Covid-19 (especially in the baseline period), and emissions from business travel may be driven more by business needs than by individual employee decisions.

[78]: Hafer *et al.* (2017)
[79]: Kaselofsky *et al.* (2020)
[82]: Lou *et al.* (2019)
[86]: Iria *et al.* (2020)

[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[77]: Patricio *et al.* (2022)
[313]: Colabi *et al.* (2022)

[630]: Deutscher Wetterdienst (2022)

[629]: Nord Stream (2022)

## 12.6 Implications

The results contribute to the existing literature and practical design of gamification in various dimensions.

### 12.6.1 Implications for Theory

[111]: Nacke *et al.* (2017)
[261]: Ryan *et al.* (2017)
[166]: Ajzen (1991)
[168]: Morren *et al.* (2016)
[169]: Katz *et al.* (2022)
[133]: Lindenberg *et al.* (2013)
[136]: Canto *et al.* (2023)

Following the call for more theory-driven investigations of gamification [111], particularly beyond general motivational theories such as SDT [261] and considering topic-specific theories to design and evaluate gamification for sustainable employee behavior, this study combined the lenses of two explanatory theories. On the one hand, the TPB [166] as a general behavior formation theory that has been shown to be a reliable predictor of sustainable employee behavior [168], [169] and, on the other hand, goal-framing theory [133] as a topic-specific theory of psychological drivers of sustainable behavioral intentions that has only recently received attention in research on sustainable employee behavior [136].

[162]: Stern (2000)

The findings contribute to expanding the theoretical understanding of sustainable employee behavior by highlighting that although the rational choice process posited by the TPB is supported, hedonic and normative goal frames are equally important in shaping sustainable behavioral intentions. Specifically, the results show that rational choice processes (gain goal frame), beliefs and norms of the VBN theory [162] (normative goal frame), and hedonic enjoyment of sustainable behavior (hedonic goal frame) in combination can almost fully explain the variance in behavioral intentions. Thus, the framework has proven to be a valuable perspective from which to examine the psychological trajectories of the effects of gamification and, in particular, various game design elements, and further theory-driven research is invited to build on these theoretical lenses and further explore how various indicators (e.g., attribution of responsibility for the normative goal frame) can help to further explain the path to sustainable employee behavior. Given that the observations of this study show that the explanatory power of behavioral intentions for self-reported sustainable behaviors still has room for improvement, further research is needed to examine this intention-action gap in particular and explore how gamification might help to bridge it.

As a contribution to previous research on gamification and green IS for sustainable employee behavior, this study reveals that there is indeed a visible pathway from gamified applications over behavioral interventions to sustainable employee behavior via the normative goal frame and the gain goal frame. Thus, gamification succeeds in aligning rational choice processes, particularly perceived behavioral control and subjective norm, with the normative goal frame, which is critical from the perspective of goal frame theory [133]. On the other hand, gamification seems to be unable to reconcile the hedonic goal frame, i.e., hedonic enjoyment in sustainable behavior [133], with the gain and normative goal frame. Therefore, further studies are warranted to investigate how more immersive gamification design elements such as storytelling or gamification design elements in combination with novel technologies such as augmented reality might be able to promote hedonic enjoyment in sustainable behavior and thereby align the hedonic goal frame with the normative goal frame.

Finally, at the methodological level, this study underscores the importance of considering neither survey data alone nor behavioral data alone, particularly because behavioral data may not reflect actual experiences. In particular, the analysis demonstrates that observed sustainable behavior within the application is not necessarily related to psychological experiences and self-reported sustainable behavior (e.g., considering only behavioral data may have led to the conclusion that hedonic elements positively influence sustainable behavior, while survey data reveal a negative effect). While behavioral data can provide valuable insights into user patterns within a gamified application, survey data are essential to understanding how in-app behavior translates into psychological and behavioral outcomes. Only together is it possible to improve understanding of how different gamification design elements impact the path to sustainable employee behavior, and further research is encouraged to explore additional data collection methods, such as on-site observations, to expand understanding of the impact of different gamification designs on sustainability in organizational environments.

### 12.6.2 Implications for Practice

The results of this study provide valuable insights that can help in the practical design of gamification for sustainable employee behavior at work.

First, companies considering using gamification as an intervention to motivate sustainable employee behavior should implement gamification as a short-term campaign for sustainable behavior in the workplace to particularly benefit from the attention and interest generated by the novelty effect. Consistent with the findings of previous short-term interventions [78], [82], [84], [87], the findings of this study demonstrate that even short-term use of gamification can lead to notable effects on learning and perceived behavioral control, thereby influencing sustainable employee behavior, resulting in visible corporate-level effects. However, prolonged use of gamification can lead to counterproductive effects such as logging fatigue and boredom, which can undermine positive short-term effects. In this regard, designers of gamified systems may consider implementing automatic tracking methods whenever possible to reduce the effort required to record sustainable behavior for employees, while carefully considering ethical concerns such as privacy and surveillance [85], [197], [588] that may be associated with automatic tracking.

[78]: Hafer *et al.* (2017)
[82]: Lou *et al.* (2019)
[84]: Oppong-Tawiah *et al.* (2020)
[87]: Wunsch *et al.* (2016)

[85]: Stroud *et al.* (2020)
[197]: Mulcahy *et al.* (2019)
[588]: Lilley *et al.* (2013)

Second, because gamification and especially utilitarian elements can significantly influence sustainable employee behavior via the trajectory of perceived environmental knowledge, pro-environmental attitude and perceived behavioral control, gamification designers, for all their efforts in considering hedonic and social aspects in design, should first focus on providing utilitarian benefits to employees and enabling them to set goals, get guidance, and monitor their progress. Traditional PBL elements [634] may be helpful in this regard, but they are not sufficient to provide employees with the guidance needed towards sustainable behavior. In particular, the content of the gamified application, i.e., the goals and suggested sustainability actions provided to employees, as well as new and unlockable content, was highlighted by employees as supportive in this respect. In this context, it is also important to consider that employees have different starting points and prior knowledge of sustainable behavior, and personalization approaches [413] are highly recommended to ensure that each employee sees a utilitarian benefit in the gamified intervention.

[634]: Schöbel *et al.* (2021)

[413]: Klock *et al.* (2020)

Finally, to benefit from the potential impact of gamification on corporate sustainability, companies using gamification should ensure that a critical mass of employees participate in the intervention so that, on the one hand, subjective norms for sustainable behavior are activated [166], and, on the other hand, the participation rate is high enough that employee behavior can elicit measurable corporate outcomes. While extrinsic motivation can also have potential pitfalls that should not be ignored [13], [367], [594], extrinsic incentives and rewards can be an appropriate approach in short-term interventions to initially encourage employees to participate [583], [596] and thus lay the foundation for social drive towards sustainable behavior.

[166]: Ajzen (1991)

[13]: Delmas *et al.* (2013)
[367]: Deci *et al.* (1999)
[594]: Iweka *et al.* (2019)

[583]: Koo *et al.* (2015)
[596]: Handgraaf *et al.* (2013)

## 12.7 Conclusion and Limitations

While previous research has examined various psychological and behavioral outcomes of gamification for sustainable behaviors in work environments, previous studies deficiently understood how various design elements affect psychological outcomes and how these translate into behavioral intentions and behavior change, particularly across various dimensions of sustainable employee behaviors in the workplace. The purpose of this study was to provide meaningful insights and a deeper understanding of how gamification impacts corporate sustainability by examining the psychological, behavioral, and corporate outcomes of using a gamified application for employee sustainability and, in particular, various design elements within the application at work. Results show that gamification and, in particular, utilitarian design elements, even in a short time frame, due to the novelty effect of gamification, influence sustainable employee behavior via a trajectory of perceived environmental knowledge (normative goal frame) and pro-environmental attitude and perceived behavioral control (gain goal frame), which positively influence behavioral intention and thus increase self-reported sustainable behavior. In this way, measurable corporate sustainability outcomes can be achieved.

However, this study is not without limitations. First, it should be noted that employee participation rates, particularly in the larger companies, suggest a certain risk of self-selection bias, as participation in the field experiment was voluntary. Thus, supported by high descriptive scores in the pretest, the user base may have consisted primarily of employees who are interested in the topic of sustainability and already have a positive attitude toward sustainable behavior. This may have reduced the impact of the gamified application on psychological outcomes. Further studies should investigate whether and how employees who are not yet in the awareness stage for sustainable behavior [333] can be motivated by gamification to adopt sustainable behavior in the workplace.

[333]: Prochaska *et al.* (1982)

On the other hand, it must be acknowledged that at the level of psychological outcomes, the sample size consisted of only a subset of 52 employees who completed both surveys, which may have affected the validity of the results. Future research should build on the findings of this study and expand the survey with a larger sample to confirm the observed trajectory of the impact of gamification on sustainable employee behavior.

Third, as is common with field experiments, this study is based on a specific gamified application with its own utilitarian, hedonistic, and social elements, the categorization of which is generally debatable, as it often depends on the user whether a particular element is perceived as utilitarian or hedonic [635]. Further research is encouraged to validate the generalizability of this study's findings with other gamified interventions to strengthen theory building through practical IS research [90], and to vary aspects of the design to gain more insight into the particular impact of the specific design of utilitarian, hedonic, and social elements in gamification for sustainable employee behavior.

[635]: Köse *et al.* (2019)

[90]: Lehnhoff *et al.* (2021)

The preceding summative evaluation of the gamified application led to the following key insights:

- There is a novelty effect in the use of gamification, suggesting that gamification is best used as a short-term intervention
- Even in a short period of time, gamification can influence sustainable employee behavior through a psychological trajectory from activated gain goal frames (especially perceived behavioral control and pro-environmental attitude) and normative goal frames (perceived environmental knowledge) to behavioral intentions
- Utilitarian elements are most important in eliciting positive psychological outcomes, while hedonic elements particularly influence observed sustainable behavior in the gamified application
- Overall, gamification can lead to considerable impacts on corporate sustainability, especially in terms of energy savings, paper consumption, and recycling, if participation rates are sufficient

# Discussion and Contributions

# 13 Discussion and Implications



Given the urgency of climate change, companies are increasingly challenged to contribute to sustainable development [8], [11], [636]. Yet, corporate efforts have been criticized as insufficient [14], [17], particularly due to a lack of employee engagement in corporate sustainability [18], [20]. In this context, IS, especially green IS, have been proposed and explored as possible means to motivate sustainable employee behaviors in the workplace [40], and in recent years, attention has increased on how traditional feedback-oriented systems can be augmented with gamified elements to create positive affective and social experiences [44], [47], [84].

[8]: Aguilera *et al.* (2021)
[11]: Wood (2022)
[636]: Williams *et al.* (2019)
[14]: Whiteman *et al.* (2013)
[17]: Ergene *et al.* (2020)
[18]: Wolf (2013)
[20]: Kim *et al.* (2017)
[40]: Singh *et al.* (2020)
[44]: Pasini *et al.* (2017)
[47]: Hillebrand *et al.* (2021)
[84]: Oppong-Tawiah *et al.* (2020)

However, in a comprehensive review of the current state of research (**Study 1**), existing studies on the potential of gamification to motivate sustainable employee behavior reveal three main shortcomings: a) they often *failed to incorporate general motivational, behavioral, or topic-specific theories in design and evaluation*, which corresponds to a general shortcoming of theory-driven gamification research [111]; b) they lacked a *proper understanding of how different gamification elements elicit specific psychological effects and how these translate into behavioral change*, i.e., the trajectory from gamification as an "input" to behavior as an "output" remained unexplored, and c) they *rarely examined the impact on sustainability at the corporate level*, focusing either on the subject of health, energy savings, or innovation, but neglecting the variety of sustainability dimensions to which employees might contribute. From a practical perspective, therefore, there is a lack of holistic, applicable solutions to motivate different sustainable behaviors among employees at work, which collectively add to the company's contribution to sustainable development.

[111]: Nacke *et al.* (2017)

The goal of this dissertation project was therefore to *explore the potential of gamification to motivate sustainable employee behaviors* in the workplace by *conceptualizing, designing, and evaluating a holistic gamified intervention that supports employees in various sustainable behaviors in their daily activities* in a DSR approach [91], [101]. As part of the iterative design process, the project a) *drew on topic-specific gamification design theories for the design and sustainable behavior and technology adoption theories for the evaluation of the application*. Thereby, it aimed to b) *increase understanding of the psychological mechanisms of gamification and gameful design*, *explore contextual challenges in implementing gamification in an organizational context* that arise from employee motivations, expectations, and experiences, and c) *understand how gamification influences sustainable employee behaviors in organizations*. In addition, the research project sought to provide several practical contributions to the design of gamification, green IS, and sustainable employee behavior interventions in general.

[91]: Peffers *et al.* (2007)
[101]: Kuechler *et al.* (2012)

## 13.1 Theoretical Contributions and Implications

By conducting six studies along the design and evaluation of a gamified application for sustainable employee behavior in the workplace, this research project yielded significant theoretical contributions to *advance gamification design theory and the theoretical understanding of gamification design in general*, to *understand how gamification can act as a solution to motivate sustainable employee behavior*, and to *understand how gamification for sustainable employee behavior translates into organizational outcomes*.

### Contributions to Advance Gamification Design Theory and Theoretical Understanding of Gamification Design in General

Taking a *design perspective* on gamification for sustainable employee behavior in particular and gamification design in general, this project has comprehensively examined theoretical foundations in research on gamification, serious games, and game-based learning (**Study 2**) and empirical research on design principles for gamification and persuasive systems (**Study 3**).

In response to the call to advance understanding of how and why gamification works [111], [119] as a critical prerequisite for designing effective gamified interventions [48], [110], **Study 2** showed that the major theoretical foundations used to explain the effects of gamification share notable conceptual relationships and commonalities. In particular, in moving from an observational to an explanatory perspective on the theoretical basis of gamification, **Study 2** showed that no single theory is sufficient to understand how and why gamification works. Rather, critical reflection on prevailing theories, which can be categorized into theories of motivation and affect, learning and behavior [258], [266], especially SDT [261], flow theory [330], experiential learning theory [452], constructivist learning theory [339], cognitive load theory [116], social cognitive theory [329], situated learning theory, the sociocultural theory of cognitive development [338], the TAM [118], the TPB [166], reinforcement theory [375], and goal-setting theory [331], provided 10 theoretical principles that help explain how successful gamification works. These principles firstly lead to intended behavioral outcomes, secondly promote individual relevance of behavior, and thirdly enable positive social effects. Overall, this synthesis advances theoretical understanding of gamification and underscores that research should consider a broader variety of theoretical foundations to design and evaluate gamification, rather than building on just one of these theories [269]. Consequently, it provides a solid foundation for future theory-driven studies in gamification that test, challenge, and refine these theoretical foundations so that the "how" and "why" of gamification can be explained more concretely and precisely.

[111]: Nacke *et al.* (2017)
[119]: Dichev *et al.* (2017)
[48]: Koivisto *et al.* (2019)
[110]: Sailer *et al.* (2020)
[258]: Plass *et al.* (2015)
[266]: Bloom (1956)
[261]: Ryan *et al.* (2017)
[330]: Csikszentmihalyi (1975)
[452]: Kolb (1984)
[116]: Sweller (1988)
[329]: Bandura (2001)
[338]: Vygotsky (1978)
[118]: Davis (1989)
[166]: Ajzen (1991)
[375]: Skinner (1953)
[331]: Locke (1968)
[269]: Keller (2008)

By considering findings from user-centered empirical studies in addition to theory, **Study 3** responded to the lack of a comprehensive overview of design principles for gamification and persuasive systems that represent important guidelines for selecting design elements and affordances [221]. **Study 3** found that empirical studies proposed a variety of more than 60 different design principles, which can be divided into user-oriented principles for behavioral outcomes (subdivided into individual and social behavior principles), system-oriented principles for hedonic experiences, and context principles [531], which, in line with recommendations from gamification design methods [123], advise considering the goals of the intervention and involving the target audience in the co-design. More specifically, critical

[221]: Deterding *et al.* (2011)
[531]: Lallemand *et al.* (2015)
[123]: Morschheuser *et al.* (2018)

reflection on the proposed principles showed that most of them are consistent with the theoretical principles from **Study 2**, while some of them are also contradictory. For example, the role of behavioral incentives as positive reinforcements is supported by reinforcement theory [375], while it is criticized by cognitive evaluation theory [337], which refers to general motivational discussions about the undermining or supporting role of extrinsic on intrinsic motivation [367]. In summary, the critical discussion of empirical design principles provides a deeper understanding of how theoretical principles can be translated into more specific design principles (e.g., *P3: Immediate feedback* is specified through the empirical principles of *immediate positive feedback, data for self-monitoring,* and *progress visualization*) and constitutes a valuable contribution for both gamification researchers and designers to successfully design gamification. Furthermore, it provides a solid starting point to further explore the importance of different principles in various contexts.

[375]: Skinner (1953)

[337]: Deci *et al.* (1985)

[367]: Deci *et al.* (1999)

Finally, considering both theoretical and empirical foundations, this research project combined theory and empirics with the general aspects of user experience in motivational IS [249] by linking the level of design principles with the level of affordances [637], thereby drawing a coherent new picture of design theory for gamification consisting of utilitarian, hedonic, and social design principles (Chapter 7) that serves to guide and shape future gamification studies across all application areas and domains.

[249]: Hamari *et al.* (2015)

[637]: Deterding (2011)

### Contributions to Understand How Gamification can Act as Solution to Motivate Sustainable Employee Behavior

Taking an *individual perspective* on gamification for sustainable employee behavior, the present research project developed a theoretical framework for examining the effects and outcomes of gamification (Chapter 3, Chapter 4), On this basis, the gamification design and outcomes of previous studies on gamification for sustainable employee behavior (**Study 1**), employee motivations and design expectations in the particular context of workplace sustainability (**Study 4**), the challenges of introducing and using gamification in organizational work environments (**Study 5**), and the trajectory of gamification design elements through psychological outcomes to individual behavior change (**Study 6**) were explored.

By synthesizing perspectives from gamification research, green IS research, and sustainable employee behavior research, a theoretical framework was proposed that extends the general conceptualization of gamification [48] (Chapter 3, Chapter 4). Specifically, the framework postulates that utilitarian, hedonic, and social design elements in gamified systems, adapted from general aspects of user experience in motivational IS [249], influence psychological outcomes over the course of a process of individual technology adoption phases, as suggested by previous findings on green IS [40], [211], [215]. Consistent with previous research on sustainable employee behavior, these psychological outcomes can be divided into three goal frames [133]: The normative goal frame, which reflects the norm-oriented view of sustainable behavior [157], [162], the gain goal frame, which considers the rational choice-based view of sustainable behavior [166], and the hedonic goal frame, which builds on the natural pursuit of enjoyment [174]. The framework further suggests that these psychological outcomes drive behavioral intentions for sustainable behavior, consistent with the

[48]: Koivisto *et al.* (2019)

[40]: Singh *et al.* (2020)
[211]: Sanguinetti *et al.* (2018)
[215]: Schmermbeck (2019)

[133]: Lindenberg *et al.* (2013)

[157]: Schwartz (1977)
[162]: Stern (2000)

[166]: Ajzen (1991)

[174]: Steg *et al.* (2014)

TPB [166], which determines actual individual behavioral outcomes that cumulatively lead to corporate outcomes. The proposed framework, and in particular its further development based on the research findings of this project presented in Section 13.1, presents a novel and comprehensive view of the process of how gamification influences sustainable employee behavior that can serve as a theoretically grounded foundation for further studies in the field of gamification and green IS that examine the path to sustainable behavior in the workplace context and beyond.

[166]: Ajzen (1991)

Based on this theoretical framework, this project conducted an in-depth review of previous research on gamification for sustainable employee behavior (**Study 1**). As the first of its kind, it presented a holistic overview of current research, including the theoretical foundations used to design and evaluate gamification for workplace sustainability, various utilitarian, hedonic, and social design elements, and the psychological, behavioral, and corporate outcomes achieved. The results show that while previous research has focused on specific dimensions of workplace sustainability, such as employee health and well-being, innovation, and energy conservation, there is a lack of more holistic studies that address multiple dimensions of sustainable behavior with gamification. Whereas much of the research has focused on the design of gamification with a variety of different utilitarian, hedonic, and social elements that can serve as inspiration for further studies, it remains unclear how these elements influence psychological and behavioral outcomes. In particular, rational decision-making processes and the trajectory from psychological to behavioral outcomes are still largely unexplored. Based on these findings, **Study 1** developed a theoretical research agenda for further research in the field of gamification for sustainable employee behavior that can serve as a catalyst for future studies. Correspondingly, this thesis also addressed several of these research gaps in subsequent studies (**Study 4, 5, 6**).

In incorporating the employee perspective early in the design of gamification for sustainable behavior at work, which has been highlighted as critical to the success of gamification [123], [542], **Study 4** responded to the lack of a deep understanding of of employees' needs, motivations, and expectations, as well as the contextual characteristics of gamification in the workplace [541]. **Study 4** examined employees' motivations for sustainable behavior, guided by VBN theory [160], and their expectations of design features and found that employees are primarily egoistically motivated to behave sustainably, which crucially influences expectations of gamification design features for sustainable employee behavior: utilitarian elements that help set goals, guide toward those goals, monitor progress, and change behavior with minimal effort are most important. Hedonic and social design features were also mentioned, but mostly in the context of supporting core utilitarian functions through additional playful learning, exploration, social comparison, and reciprocal support. The results suggest that, particularly in the work context, previous assumptions that humanistic or biospheric motivations dominate [551], [552] are being challenged and that the motivations of the target audience in a specific context should always be considered when deciding on design elements in gamified systems. For future studies on gamification for sustainable behavior in particular, the results provide a valuable basis for investigating how people with different motivations for sustainability perceive and use gamification elements and how gamification can be adapted and personalized to address these different motivations.

[123]: Morschheuser *et al.* (2018)
[542]: Shahri *et al.* (2019)

[541]: Warmelink *et al.* (2020)

[160]: Stern *et al.* (1994)

[551]: Howell *et al.* (2017)
[552]: Tolppanen *et al.* (2021)

By comprehensively examining the challenges of adopting and using gamification for sustainable behavior at work, **Study 5** fills a gap in previous green IS research that has focused primarily on positivist validation of technology adoption theories [40], [195], [213], and sheds new light on the unique challenges of the work environment that can impede the adoption of gamification and thus the achievement of positive psychological and behavioral outcomes. The results of **Study 5** highlight challenges at all stages of the individual technology adoption process related to the subject (the employee), the instrument (the IS), the object (sustainable behaviors), the community (colleagues), and the rules of the workplace. Specifically, five overarching themes were identified, showing that evaluation of the use experience in the confirmation phase can in turn influence adoption by other employees in a reinforcing cycle of relevance through social pressure, while long-term motivation is a particular concern due to lack of personal consequences. In juxtaposing the challenges with motivational design theory, it became clear that the successful adoption of gamification is challenged by four core dilemmas: Pressure versus Voluntariness, Control versus Freedom, Oblivion versus Distraction, and Extrinsic versus Intrinsic Motivation. The findings of **Study 5** open a new, user-centered perspective on the process of technology adoption that invites further exploration of the dilemmas, the ways in which such dilemmas arise in other contexts, how design solutions might be able to overcome the dilemmas, and, the role and potential of extrinsic motivations in the work context, as intrinsic motivational designs alone seem to be insufficient.

[40]: Singh *et al.* (2020)
[195]: Papagiannidis *et al.* (2022)
[213]: Marikyan *et al.* (2019)

Finally, to respond to the main shortcomings of previous research, **Study 6** explored the path from gamification design to psychological and behavioral outcomes. The results of **Study 6** provided entirely new insights into how gamification influences sustainable employee behavior. Specifically, the results showed strong evidence of a novelty effect in the use of gamification, suggesting that gamification is best used as a short-term intervention, but even in a short period, gamification can successfully influence sustainable employee behavior. While the results highlight the importance of all three goal frames in forming behavioral intentions, gamification influences self-reported sustainable behaviors through a psychological trajectory from activated gain goal frames (specifically perceived behavioral control and pro-environmental attitude) and normative goal frames (perceived environmental knowledge) to behavioral intentions. In examining the effects of different elements, results further indicated that utilitarian elements are most important in eliciting positive psychological outcomes, while hedonic elements are particularly influential in tracking behavior. Qualitative findings underscored the quantitative results and provided valuable insights into employees' learning experiences when using gamification, while also revealing that prior knowledge must be considered for positive experiences and conversion of use into behavioral outcomes. As the first study to comprehensively examine the pathway from gamification to sustainable employee behavior via psychological processes, **Study 6** represents a unique contribution to understanding the impact of gamification in the context of workplace sustainability. Moreover, it serves as an anchoring point for future research to discover further pathways via various elements, particularly social and hedonic elements, not only in gamified systems but also in green IS and sustainable employee behavior interventions in general, and to explore how the intention-action gap still present in this study might be overcome.

### Contributions to Understand How Gamification for Sustainable Employee Behavior can Translate into Corporate Outcomes

From a *corporate perspective*, this research project examined both the results of previous studies that have used gamification to generate corporate outcomes (**Study 1**) and the specific corporate outcomes of using gamification to support corporate sustainability in multiple dimensions (**Study 6**).

The results of **Study 1** highlighted that previous studies considered limited measurable corporate benefits in motivating sustainable employee behavior through gamification, with mainly short-term interventions finding positive impacts on building energy savings [78], [79], [82], [84], [86] and innovation [75], [76], [313]. Therefore, the results of **Study 1** call for further research that focuses on the impact of gamification beyond the individual level and examines how gamification can influence corporate-level outcomes in various dimensions of sustainability.

[78]: Hafer *et al.* (2017)
[79]: Kaselofsky *et al.* (2020)
[82]: Lou *et al.* (2019)
[84]: Oppong-Tawiah *et al.* (2020)
[86]: Iria *et al.* (2020)

[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)
[313]: Colabi *et al.* (2022)

To contribute to this research gap, **Study 6** examined how the use of gamification for sustainable employee behavior leads to measurable outcomes at the corporate level. The results showed that gamification can lead to remarkable corporate outcomes in various sustainability dimensions, especially in energy saving, paper consumption, and recycling. However, these effects mainly depend on the participation rate of employees: The effects are greatest in smaller companies. The results also suggested that some dimensions of sustainability are more easily influenced by interventions for sustainable employee behavior than others: While gamification is able to motivate energy conservation and raise awareness of recycling, metrics such as gas and water consumption may be much more influenced by external factors such as hot weather [630], the energy crisis caused by the North Stream pipeline leak [629], or the number of employees working from home due to Covid-19, and emissions from business travel may be driven by business needs rather than individual employee decisions. While promising, future research should further explore such confounding factors and different study designs to deepen understanding of under what conditions and to what extent gamification can serve as a solution to improve corporate sustainability outcomes.

[630]: Deutscher Wetterdienst (2022)

[629]: Nord Stream (2022)

### Theoretical Framework of Gamification for Sustainable Employee Behavior

Table 13.1 provides an overview of the theoretical contributions of this research project. Taken together, the results not only constitute the basis for a myriad of future research directions in the areas of gamification, green IS, and sustainable employee behavior, but more importantly contribute to a profound understanding of gamification for sustainable employee behavior. As a result of combining the design perspective, the individual behavior perspective, and the corporate perspective, Figure 13.1 presents the findings of this research project in a framework of gamification for sustainable employee behavior that is based on the theoretical framework (Figure 3.8) of this dissertation presented in Chapter 3 and summarizes the main insights of the studies presented in this thesis.

Altogether, the research project yielded the following theoretical contributions listed in Table 13.1

Table 13.1: Summary of theoretical contributions of this research project to different perspectives on gamification for sustainable employee behavior (D = Design perspective, IB = Individual behavior perspective, C = Corporate perspective).

| Chapter | Key contributions | D | IB | C |
|---|---|---|---|---|
| Theoretical Background | ▸ Gamification can be understood as the use of games or game design elements in nonentertainment-based contexts - digital as well as non-digital - to induce positive psychological outcomes that support desired utilitarian goals<br>▸ In an extended conceptualization of gamification enlarged by findings from green IS and sustainable employee behavior research, utilitarian, hedonic and social gamification design elements induce psychological and behavioral outcomes via an individual process of adoption and use, which then translate into corporate sustainability outcomes | x | x | x |
| Study 1: Systematic Review on Gamification for Sustainable Employee Behavior | ▸ While previous research has focused on specific dimensions of sustainability at work, such as employee health and well-being, innovation, and energy conservation, there is a dearth of more holistic studies that address multiple dimensions of sustainable behavior with gamification<br>▸ In terms of gamification design, previous research has proposed and explored a range of utilitarian, hedonic, and social design elements, but it remains unclear how these elements influence psychological and behavioral outcomes<br>▸ There are many efforts to examine hedonic and normative goal frame-related psychological outcomes of gamification for sustainable employee behavior, but there is a paucity of studies exploring whether gamification can successfully influence rational decision-making processes as well<br>▸ Despite several positive individual and social behavioral outcomes of gamification for sustainable employee behavior, a lack of research exists on how gamification can translate such individual changes into measurable impacts on corporate sustainability | x | x | x |
| Study 2: Systematic Review on Theories in Gamification, Serious Games and Game-based Learning | ▸ There are many different theories related to motivation and affect, behavior and learning that help design and explain the effects of gamification<br>▸ The most prevalent theories share explicit or implicit conceptual relationships<br>▸ From these conceptual relationships, 10 key theoretical principles can be derived to explain how successful gamification design guides toward intended behavioral outcomes, fosters individual relevance, and enables social interaction and positive social effects | x | | |

Table 13.1: Summary of theoretical contributions of this research project to different perspectives on gamification for sustainable employee behavior (D = Design perspective, IB = Individual behavior perspective, C = Corporate perspective).

| Chapter | Key contributions | D | IB | C |
|---|---|---|---|---|
| Study 3: Systematic Review on Design Principles for Gamification and Persuasive Systems | ▸ There are more than 60 different design principles from various contexts that may be appropriate for successful gamification design<br>▸ The identified design principles can be divided into user-oriented individual and social behavioral principles that support desired behavioral outcomes, systems-oriented principles that support hedonic experiences and positive affective responses, and context principles that emphasize critical considerations of the intervention's goals, setting, and target audience<br>▸ Some of the principles are contradictory, and theoretical considerations can help in deciding which principles to follow in a particular context<br>▸ User and system-oriented principles can be mapped to exemplary motivational affordances to translate abstract considerations into concrete gamification design | x | | |
| Study 4: Qualitative Investigation of Design Features from Employees' Perspective | ▸ Employees are primarily egoistically motivated to contribute to sustainability at work<br>▸ Employees expect mainly utilitarian design features that help them set goals and manage their behavior with minimal effort, complemented by social and hedonic design features that evoke positive affective experiences | x | | |
| Study 5: Challenges in the Use of the Gamified App from Employees' Perspective | ▸ Employees face a variety of challenges that must be overcome in order to successfully deploy gamification and green IS in an organizational context, which can be summarized into five themes: (1) Supporting system understanding through onboarding and education, (2) Creating personal relevance through social pressure, (3) Facilitating the start of use through defaults, (4) Simplifying use by avoiding conflicts and defining the right triggers, (5) Reinforcing long-term motivation through extrinsic rewards, competence, and relatedness<br>▸ Several challenges and design suggestions are conflicting and lead to critical dilemmas in the design of the gamified application that need to be considered in the organizational context: (1) Pressure versus voluntariness, (2) Control versus freedom, (3) Oblivion versus distraction, (4) Extrinsic versus intrinsic motivation | | x | |
| Study 6: Quantitative Investigation of Effects of the Gamified App on Sustainable Employee Behavior | ▸ There is a novelty effect in the use of gamification, suggesting that gamification is best used as a short-term intervention<br>▸ Even in a short period of time, gamification can influence sustainable employee behavior through a psychological trajectory from activated gain goal frames (especially perceived behavioral control and pro-environmental attitude) and normative goal frames (perceived environmental knowledge) to behavioral intentions<br>▸ Utilitarian elements are most important in eliciting positive psychological outcomes, while hedonic elements particularly influence observed sustainable behavior in the gamified application<br>▸ Overall, gamification can lead to considerable impacts on corporate sustainability, especially in terms of energy savings, paper consumption, and recycling, if participation rates are sufficient | | x | x |

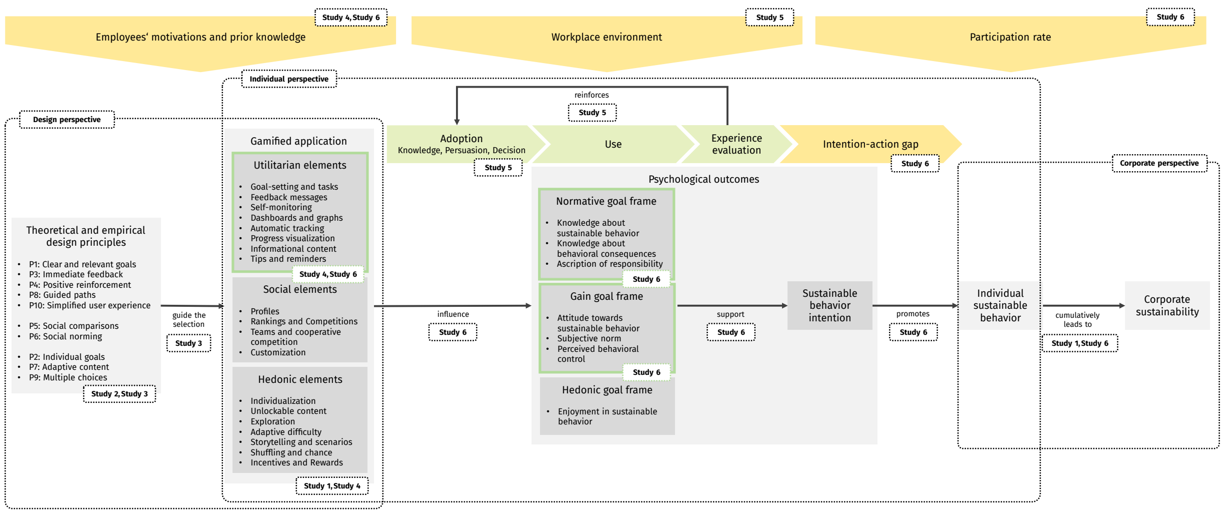


Figure 13.1: Findings of this dissertation summarized in a framework of gamification for sustainable employee behavior (elements outlined in green represent the design elements and psychological outcomes identified in **Study 4** and **Study 6** as most relevant to the trajectory towards sustainable behavior, green arrows illustrate how the technology adoption process accompanies the path from the gamified application to the outcomes and yellow elements represent the intention-action gap as an additional challenge to the adoption identified in **Study 6**, as well as relevant external influencing factors identified in this research project).

First, the design perspective has helped to derive valuable theoretical and empirical design principles (**Study 2, 3**) that can serve as a basis for the design of gamification and the selection of various utilitarian, social, and hedonic elements (**Study 3**) which may be inspired by elements used in previous research on gamification for sustainable employee behavior (**Study 1**) or employee expectations of design features (**Study 4**). In this regard, it should be noted that certain elements are not uniquely either utilitarian, hedonic, or social; rather, their appeal depends on the framing of the intervention and the perception of the individual [361], and thus their classification serves only as inspiration based on the categorization made in this research project. Particularly in the context of workplace sustainability, employee motivations (**Study 4**) and prior knowledge (**Study 6**) should be considered in this selection, as they can critically influence the perception and subjective evaluation of the gamification design. While social and hedonic elements can be very valuable in supporting utilitarian outcomes, utilitarian elements should be prioritized to break down the complex issue of sustainability, guide employees toward sustainable behaviors, and provide an opportunity for self-monitoring of progress (**Study 4, 6**).

[361]: Köse *et al.* (2019)

Second, the individual behavior perspective has served to consider the individual process of adoption and use, as well as psychological outcomes. It becomes clear that the adoption of gamification cannot be taken for granted and that various challenges in the knowledge, persuasion, and decision stages of adoption related to the workplace environment (**Study 5**) must be overcome to achieve psychological outcomes. Specifically, gamification, when successfully adopted, can activate normative and gain goal frame-related psychological outcomes in the use phase of technology adoption that influence behavioral intention when employees experience them to be favorable (**Study 6**). Through social pressure processes, positive evaluations of experiences by multiple employees may in turn reinforce adoption by others (**Study 5**). However, sustainable behavioral intentions do not always and automatically lead to sustainable behaviors; rather, an intention-action gap, which is usually present in sustainable behavior [606], [638], [639], may hinder its translation into behaviors (**Study 6**).

[606]: Rausch *et al.* (2021)
[638]: Carrington *et al.* (2014)
[639]: ElHaffar *et al.* (2020)

Third, the corporate perspective has served to move from the individual level to focus on the broader impact of gamification on corporate sustainability. It has been shown that individual behavioral changes induced by gamification can cumulatively lead to visible contributions to corporate sustainability (**Study 1, Study 6**). However, participation rates are particularly critical to enable cumulative impact (**Study 6**), and companies should consider this aspect in their communications and accompanying measures around the gamified intervention itself, with extrinsic incentives especially likely to be of value in increasing participation (**Study 4, Study 5**).

## 13.2 Practical Contributions and Implications

In addition, through iterative theory-driven suggestions and refinements, this research project provided valuable practical contributions to the *design of gamification for sustainable employee behavior in organizations*. Specifically, this research project yielded three design approaches for gamification to support sustainable employee behavior (Table 13.2), the development of which is detailed below.

**Study 1** first identified three general approaches to designing gamification for sustainable employee behavior based on goal-framing theory [133] and design elements and outcomes from previous studies: The *cost-benefit approach*, where the focus is on the core message that sustainable behavior is beneficial from a rational-choice perspective; the *hedonic approach*, where the key message is that sustainable behavior is fun; and the *normative approach*, which aims to convey the message that sustainable behavior is the right thing to do. Accordingly, several possible design elements were proposed for each of these approaches, with the cost-benefit approach focusing on utilitarian elements for self-efficacy and achievement-related hedonic elements, the hedonic approach focusing on hedonic elements that promote immersion and curiosity and social elements that create playful challenge, and the normative approach focusing on utilitarian elements for learning and social elements that create social pressure.

[133]: Lindenberg *et al.* (2013)

Through a comprehensive review of the theoretical underpinnings in research on gamification, serious games, and game-based learning (**Study 2**) and the empirical design principles for gamification and persuasive systems (**Study 3**), ten theoretical principles for gamification design and associated empirical principles were identified that can be used in selecting design elements in the three approaches. In particular, utilitarian principles, i.e., clear and relevant goals, immediate feedback, positive reinforcement, guided paths, and simplified user experience, can help in selecting potential design elements in the cost-benefit approach, while hedonic principles (individual goals, adaptive content, and multiple choices) can assist in choosing affordances in the hedonic approach. Finally, social principles, i.e., social comparison and social norming, can guide the selection of design elements in the normative approach.

**Study 4** revealed two important insights for the design of gamification for sustainable employee behavior: First, because employees appear to be primarily egotistically motivated [160] to behave sustainably, they largely expected design features related to the cost-benefit approach, i.e., goal setting and guidance, and positive reinforcement, suggesting that the

[160]: Stern *et al.* (1994)

cost-benefit approach should be the focus of consideration when designing gamification for sustainable employee behavior (Figure 13.2). Second, employees highlighted general design recommendations that should be followed regardless of the approach: Organizations should ensure that gamification fits seamlessly into daily work tasks, and gamification designers in their efforts to provide functionality [250] should also pay attention to aesthetic design and usability [640] (Figure 13.2).

[250]: Mora *et al.* (2017)

[640]: Suh *et al.* (2017)

In addition, **Study 5** led to critical insights into design dilemmas that gamification designers must consider with each of the approaches. In particular, for the cost-benefit approach, although the relevance of extrinsic incentives to long-term motivation was reiterated by employees, designers should carefully consider whether extrinsic incentives might undermine intrinsic motivation [13], [367], [594] in their target group, or whether extrinsic motivation is essential to motivate employees in the first place [583], [595], [596], and carefully balance the design of the application itself in terms of potential distraction from daily work [592], [593] while still ensuring that it does not fall into oblivion. For the hedonic approach, the dilemma of control versus freedom gains particular relevance, and designers must decide the extent to which rules and surveillance constrain exploration of different possibilities and potentially limit creative approaches [48], [588], while ensuring that the application is used in the intended way and leads to the intended behavior change. And third, for the normative approach, the dilemma of pressure versus voluntariness takes on specific importance, i.e., designers who want to benefit from positive social dynamics toward sustainability in the workplace [74], [77], [316] should be alert to potential pitfalls for workplace atmosphere and relationships with colleagues [85], [586]. Since there is no definite right or wrong approach to solving these dilemmas, it is strongly recommended that gamification designers involve their target audience in co-design and decide together which design decision best suits the particular audience and corporate environment [599], [600] (Figure 13.2).

[13]: Delmas *et al.* (2013)
[367]: Deci *et al.* (1999)
[594]: Iweka *et al.* (2019)

[583]: Koo *et al.* (2015)
[595]: Lossin *et al.* (2016)
[596]: Handgraaf *et al.* (2013)

[592]: Mani *et al.* (2017)
[593]: Yoon *et al.* (2021)

[48]: Koivisto *et al.* (2019)
[588]: Lilley *et al.* (2013)

[74]: Agogué *et al.* (2015)
[77]: Patricio *et al.* (2022)
[316]: Omiya *et al.* (2019)

[85]: Stroud *et al.* (2020)
[586]: Tsai *et al.* (2017)

[599]: Ågerfalk *et al.* (2022)
[600]: Cherry *et al.* (1999)

Finally, the findings of the field experiment in **Study 6** again reinforced placing the cost-benefit approach with a focus on learning and self-efficacy and support for simplification and tracking at the center of the design (Figure 13.2), complemented by normative approaches to promote awareness, learning, and subjective norms. In addition, the novelty effect observed in **Study 6** suggested that all gamification approaches are best designed as multiple short-term interventions rather than long-term interventions to capitalize on initial awareness and interest in the novel intervention. Furthermore, to achieve corporate sustainability benefits, companies should ensure that a critical mass of employees participate [641], which is why a gamified intervention alone is probably not sufficient: rather, accompanying communication and campaigns (e.g., [87], [323]) are needed to drive awareness and communicate the relevance of the intervention.

[641]: Gupta *et al.* (2017)

[87]: Wunsch *et al.* (2016)
[323]: McKeown *et al.* (2016)

Collectively, the results of this research project provide a guide to the practical design of gamification for sustainable employee behavior by identifying three design approaches (Table 13.2), all of which have their benefits and potential pitfalls.

Altogether, the research project yielded the following practical design approaches listed in Table 13.2

Table 13.2: Details of design approaches for gamification to support sustainable employee behavior.

| Design approach | Cost-benefit approach | Hedonic approach | Normative approach |
|---|---|---|---|
| Core message (based on goal-framing theory) | Sustainable behavior is beneficial | Sustainable behavior is fun | Sustainable behavior is the right thing to do |
| Focused psychological outcomes | Attitude towards sustainable behavior<br>Self-efficacy in behaving sustainably<br>Knowledge on sustainable behavior and behavioral consequences | Motivation to behave sustainably<br>Fun in sustainable behavior<br>Enjoyment in sustainable behavior<br>Immersion | Awareness of the need for sustainable behavior<br>Knowledge on sustainable behavior and behavioral consequences<br>Reflection on behavior<br>Motivation to behave sustainably |
| Theoretical and empirical principles | P1: Clear & relevant goals<br>P3: Immediate feedback<br>P4: Positive reinforcement<br>P8: Guided paths<br>P10: Simplified user experience | P2: Individual goals<br>P7: Adaptive content<br>P9: Multiple choices | P5: Social comparisons<br>P6: Social norming |
| Possible design elements | Focus on utilitarian elements for self-efficacy and achievement-related hedonic elements, e.g.<br>Direct feedback<br>Goal-setting and tasks<br>Dashboards and graphs<br>Tips and reminders<br>Automatic tracking<br>Progress visualization (Points, Badges, Levels)<br>Rewards and Certificates | Focus on hedonic elements that promote immersion and curiosity and social elements that evoke playful challenge, e.g. Individualization<br>Storytelling and scenarios<br>Unlockable content<br>Quiz<br>Shuffling and chance<br>Challenge<br>Leaderboard | Focus on utilitarian elements for learning and social elements for social pressure, e.g.<br>Informational content<br>Instruction and instructional workshops<br>Self-evaluation<br>Suggestive questions<br>Teams<br>Social sharing |
| Design dilemmas to care for | Extrinsic versus intrinsic motivation<br>Oblivion versus distraction | Control versus freedom | Pressure versus voluntariness |
| Potential pitfalls | Potentially undermining effects of extrinsic motivation on intrinsic motivation | Potential lack of translation into behavior change, particularly in learning-focused interventions | Potentially negative effects on workplace atmosphere and colleague relationships |
| General design recommendations | Seamless integration into daily work tasks<br>Aesthetic design and ease of use<br>Multiple short-term interventions<br>Accompanying communication | | |

The insights from the studies help designers make design decisions by transparently deriving valuable design principles, providing possible design elements, and highlighting potential dilemmas and pitfalls to be aware of, along with general design recommendations that should always accompany the design of gamification for sustainability in the workplace (Figure 13.2). While it is generally recommended to focus on the cost-benefit approach with utilitarian elements, hedonic and normative approaches can meaningfully complement the cost-benefit approach. In particular, to achieve the best results, companies should design and implement multiple short-term interventions.

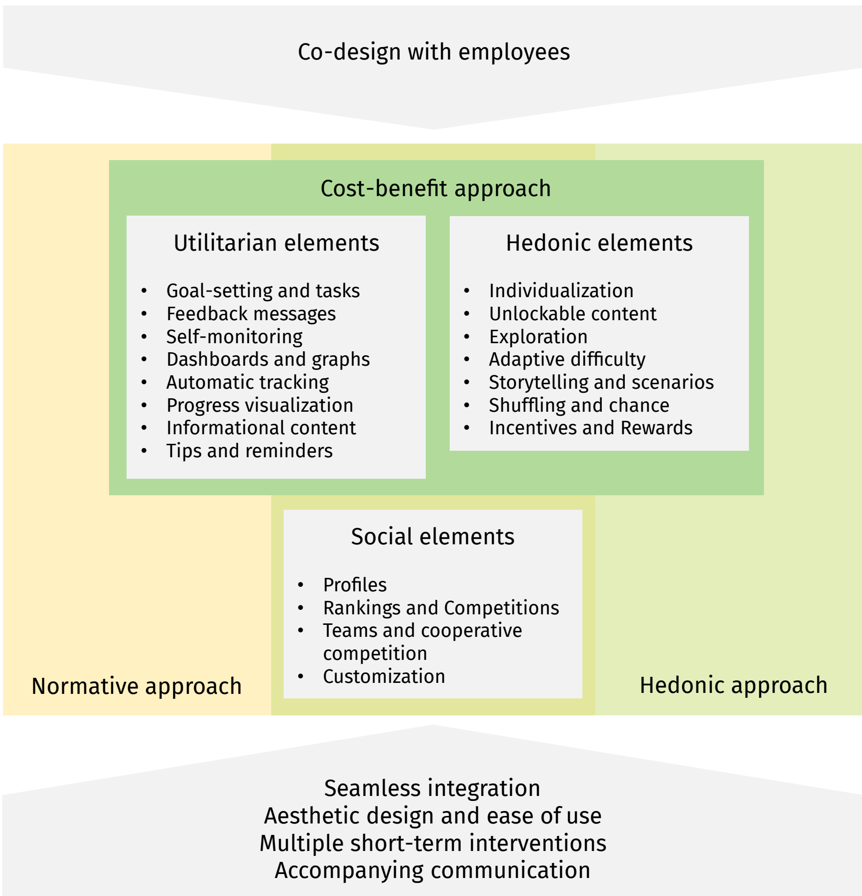


Figure 13.2: Summary of design approaches for gamification to support sustainable employee behavior.

For instance, companies could start with gamified workshops that raise awareness and knowledge about sustainable behaviors in the workplace (normative approach), followed by a one-month intervention that educates employees about their daily habits and tracks their energy use, waste generation, or other key metrics, combined with rewards for specific achievements (utilitarian approach). To consolidate learning gains and promote immersion in sustainable behaviors, employees could then be invited to play a simulation game with multiple workplace scenarios and quizzes about sustainable behaviors in the workplace that result in a virtual world evolving in a positive or negative direction (hedonic approach), followed by a month-long challenge in which employees use the same application as in the first month, but this time compete against each other in teams or corporate sites in a collaborative-competitive approach, with the winner being awarded a team event (utilitarian and normative approach). As the last example shows, the approaches are not mutually exclusive, but can be combined when appropriate to achieve the best results.

## 13.3 Ethical Reflection of the Research Project

In addition to the merits and potential of gamification demonstrated in this research project to motivate sustainable employee behaviors in the workplace and thus contribute to sustainable development at the corporate level, it is also important to consider ethical pitfalls of gamification that affect not only this work, but also future research efforts and the practical implementation of the design approaches proposed in the previous section. The following discussion covers such ethical considerations and how this research project has addressed these concerns in order to minimize potential ethical risks.

Previous research has pointed to several ethical risks of gamification in the workplace context [642]. First, gamification carries the risk of employee exploitation [298], [643], [644]. Although this risk exists primarily in contexts where gamification is used to improve job performance [642], [645] rather than in the context of sustainability, which is intended to serve the community rather than the individual employer, the potentially manipulative nature of gamification at the expense of employee autonomy is a frequently criticized aspect [642], [643], [645]. Precisely because gamification designs are intended to evoke feelings of flow [330], e.g., through elements that imply continuous achievement and progress in a given task, such as juicy feedback, badges, and points, they can also have addictive potential [646]. Thus, to promote employee agency in the use of gamified systems in the work environment, the voluntary nature of participation has been highlighted as critical [226], [586], [587] - although **Study 5** points to a potential tension between voluntariness and social pressure mechanisms necessary to generate personal relevance to the specific issue of workplace sustainability, which needs to be explored further in the future. To address the potential risk of manipulation, this research project, particularly **Study 6**, designed *participation as voluntary* and empowered agency through the *iterative co-design process* with the target group [599].

[298]: Shahri *et al.* (2014)
[643]: Kim *et al.* (2016)
[644]: Kim (2015)

[642]: Nyström (2021)
[645]: Kim (2018)

[330]: Csikszentmihalyi (1975)

[646]: Andrade *et al.* (2016)

[226]: Huotari *et al.* (2017)
[586]: Tsai *et al.* (2017)
[587]: Saeed *et al.* (2013)

[599]: Ågerfalk *et al.* (2022)

Second, gamification mechanisms such as points tend to quantify employee behavior, at least to some degree, which poses the risk of surveillance and invasion of privacy [298], [588]. Notably, in **Study 5**, employees also indicated that they were concerned about the adequacy of data protection as a potential barrier to adoption of the gamified system. Research has already pointed out the potential conflict between data collection and processing in gamified systems and employees' privacy rights [647]. In this research project, several precautions were taken to avoid violating employee privacy, following common approaches to appropriate data collection and storage [647]: The application collected *as little personal data as possible* to ensure proper authorization and protect the data from external access, as well as to provide the functionality of the personal profile, i.e., only the employees' email addresses for registration and login and their name for display in the application (a picture was optional). Data on employee behavior in the gamified application was *stored only in pseudonymous form* to allow linkage of behavior to the surveys without inference to natural persons, and data analysis was presented anonymously. Also, the *companies were not granted any data analysis beyond that presented in this thesis or access to the database*, so it was impossible to analyze the behavior of specific individuals from the employers' side.

[588]: Lilley *et al.* (2013)

[647]: Ruggiu *et al.* (2022)

Third, competitive gamification mechanisms may present the risk of negative social effects on workplace atmosphere and relationships between colleagues [321], [642]. Although social pressure mechanisms can also be a positive factor contributing to the adoption of gamification in the work context (**Study 5**) and several studies have reported positive effects of gamification on team feeling and cohesion [73], [74], employees' well-being can be critically infected if their willingness to participate is low and they feel socially coerced to do so [321]. In addition to the aforementioned *voluntary nature of participation*, other mitigation strategies were used in this research project to avoid negative social effects [648]: the *leaderboard displayed only the top ten employees* to avoid downward comparisons [389] and to preserve the anonymity of those employees who were not top performers or chose not to continue using the application. In addition, *no employee was forced to participate in a competition or collaboration*, as participants had to actively commit to joining a team, team goal, or competition goal.

[321]: Hammedi *et al.* (2021)
[642]: Nyström (2021)

[73]: Cheng *et al.* (2022)
[74]: Agogué *et al.* (2015)

[648]: Algashami *et al.* (2018)

[389]: Festinger (1954)

# Limitations and Outlook 14

Despite the valuable theoretical and practical contributions of this dissertation research outlined in the discussion, there are also some limitations of this project that should be acknowledged and may be the subject of future research efforts. Since the individual limitations of the studies have been explained in each individual chapter, this section focuses on the general limitations of the research project as a whole.

By first contrasting the contributions of this study with the research gaps outlined in **Study 1**, it becomes evident that this project has helped to advance knowledge on the following agenda points:

- (1) + (8) **Studies 4, 5, and 6** examined the potential of gamification to support sustainable employee behaviors in the workplace in a more holistic approach that included multiple dimensions of sustainability, such as. water conservation (SDG 6), energy conservation (SDG 7), travel emissions (SDG 11), and waste production and recycling (SDG 12), and **Study 6** examined corporate outcomes related to these dimensions
- (2) The gamified application included utilitarian, hedonic, and social elements, notably also unlockable content, motivational messages, and adaptive difficulty
- (4) **Study 6** examined the relative influence of different design elements on encouraging sustainable employee behavior
- (5) The design and evaluation of the gamified application drew on several general and topic-specific theories from gamification, green IS and sustainable employee behavior research
- (6) + (7) **Study 6** examined how various psychological outcomes related to hedonic, gain, and normative goal frames translate into behavioral intentions and how these result in individual behavior and corporate outcomes

Nevertheless, there are several issues that have not been addressed in this research project.

On the one hand, previous research has focused primarily on competitive or collaborative-competitive designs, and given that previous research suggests that sustainability primarily requires collective rather than individual effort [365] and that collaborative approaches potentially perform better than competitive designs in terms of user engagement [123], future research still needs to explore the particular value of collaborative elements for sustainable employee behavior, which were not separately explored in this research project.

[365]: Lozano (2007)

[123]: Morschheuser *et al.* (2018)

On the other hand, both **Study 1**, **Study 4**, and **Study 6** indicated that inter-individual differences in employees' motivations and needs (such as types of players [349], [350] or motivations for sustainable behavior [160]) as well as their prior knowledge about sustainability need to be taken into account in order to successfully design gamification. While adaptive or tailored gamification has gained attention as a research direction in recent years [413], it was not implemented as part of this research project and

[349]: Marczewski (2015)
[350]: Bartle (1996)

[160]: Stern *et al.* (1994)

[413]: Klock *et al.* (2020)

should be further explored in future research endeavors in the context of sustainable employee behavior.

In addition, the current project combined an individual perspective on sustainable employee behavior with a corporate perspective that explores how individual behavioral changes can cumulatively lead to measurable corporate sustainability outcomes. However, social dynamics beyond subjective norms, such as group cohesion [73], knowledge sharing [74], [77] or communication [75], [76], and how these influence both individual behavior and collective sustainability efforts at the corporate level, were not explored further in the field experiment. Further research is therefore encouraged to focus on the role of social dynamics and interaction in influencing corporate sustainability.

[73]: Cheng *et al.* (2022)

[74]: Agogué *et al.* (2015)
[77]: Patricio *et al.* (2022)

[75]: Patricio *et al.* (2020)
[76]: Patrício *et al.* (2021)

Finally, although the qualitative results (**Study 4, Study 5**) highlighted the need for extrinsic incentives for long-term behavior change and a feature for company-wide goals with rewards was implemented in the gamified application, none of the participating companies agreed to offer incentives to their employees. Consequently, the impact of extrinsic rewards on participation, the process of behavior change, and corporate outcomes could not be investigated in this project and deserves further research attention.

In addition to these thematic limitations, there are also crucial methodological limitations of this study. While meticulous data collection aimed to reduce any interviewer bias in **Study 4** and **Study 5** [649] (by prescribing interview guides to avoid suggestive questions or responses) and the quantitative survey design in **Study 6** a) used validated scales to reduce measurement bias [650], b) was designed pseudonymously to reduce social desirability bias [651], and c) asked questions in randomized order to avoid question order bias [652], there were still other potential biases that could not be eliminated. Across all studies, generalizability suffers from the fact that a specific gamified application was developed, presented, and evaluated, and the sampling also could also involve a particular self-selection bias [649], as participation in the individual interviews (**Study 4**), focus groups (**Study 5**), and field experiment (**Study 6**) was voluntary. Furthermore, because there was no incentive to complete the field experiment and finish the surveys, **Study 6** in particular may have suffered from non-response bias [653] of those who stopped using the gamified application early and did not respond to the second survey. While triangulation of behavioral log data, quantitative and qualitative survey data, and key metrics ought to help reduce the potential impact of common method bias [654] on outcome interpretation, future research using different gamified approaches, including all employees at different stages of sustainable behavior change [333], and considering appropriate incentives to reduce non-response bias are encouraged to explore the generalizability of the results.

[649]: Pannucci *et al.* (2010)

[650]: Smith *et al.* (2014)

[651]: Grimm (2010)

[652]: Perreault (1976)

[653]: Sackett (1979)

[654]: Kock *et al.* (2021)

[333]: Prochaska *et al.* (1982)

# Conclusion 15

The goal of this dissertation project was to explore the potential of gamification to motivate employees to engage in sustainable behaviors in the workplace by conceptualizing, designing, and evaluating a holistic gamified intervention that supports employees in various sustainable behaviors in their daily activities in a DSR approach. In response to research gaps in previous studies, the project aimed to improve understanding of the psychological mechanisms of gamification and gameful design, explore contextual challenges in implementing gamification in an organizational context that arise from employee motivations, expectations, and experiences, and understand how gamification influences sustainable employee behaviors in organizations. Accordingly, this dissertation developed a theoretical framework of gamification for sustainable employee behavior and systematically reviewed contributions from previous research, theoretical foundations, and empirical design principles to derive recommendations for the effective design of a gamified application to support sustainable employee behavior. Through empirical studies that iteratively evaluated the gamified application, this project generated insights into employee motivations and expectations, discovered challenges in adopting and using gamification and critical design dilemmas to consider when designing gamification for sustainable employee behavior, and identified pathways from various gamification design elements to corporate sustainability via psychological processes and individual sustainable behavior. Based on these findings, this dissertation presented a comprehensive framework of gamification for sustainable employee behavior that encompasses the design, individual behavior, and corporate perspectives, and derived practical recommendations for designing gamification to motivate sustainable employee behavior at work.

# Appendix

# A Gamification for Sustainable Employee Behavior

## A.1 List of Excluded Full-Texts

Table A.1: List of excluded full texts during the review on gamification for sustainable employee behavior.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Conference | Alloghani et al., 2017 [655] | Gamification in e-Governance | Proceedings of the 5th International Conference on Information and Education Technology - ICIET '17 | CA: Insufficient method description |
| Conference | Arnab et al., 2020 [656] | Play in Farming: Seriously? | Proceedings of the 13th European Conference on Game Based Learning | CA: Insufficient method description |
| Conference | Botha & Herselman, 2015 [657] | ICTs in Rural Education | Proceedings of the 2015 Annual Symposium on Computing for Development | CA: Insufficient method description |
| Journal | Grèzes et al., 2021 [658] | The Co-innovation Bingo: An Object-Oriented Networking Mechanism to Foster Coupled Open Business Innovation | Business Systems Research Journal | CA: Insufficient method description |
| Journal | Richardson & Mackinnon, 2018 [659] | Becoming Your Own Device: Self-Tracking Challenges In The Workplace | Canadian Journal of Sociology | CA: Insufficient method description |
| Conference | SanaulHaque et al., 2017 [660] | A theory-driven system model to promote physical activity in the working environment with a persuasive and gamified application | Proceedings of the DDGD 2017 Workshop | CA: Insufficient method description |
| Conference | Gonçalves et al., 2016 [661] | Development of gamification-based software for permanent education of nursing technicians on high surveillance drugs | 2016 Proceedings of the Regional Conference on Educational Technologies | Not English |

Table A.1: List of excluded full texts during the review on gamification for sustainable employee behavior.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Book section | Burt et al., 2018 [662] | Validation of a gamified measure of safety behavior: The SBT | Safety and Reliability – Safe Societies in a Changing World | Book section |
| Book | Klein et al., 2016 [663] | The hygiene games | Studies in Health Technology and Informatics | Book |
| Journal | Behl et al., 2022 [664] | Improving Inclusivity of Digitalization for Employees in Emerging Countries Using Gamification | IEEE Transactions on Engineering Management | No relation to SDGs |
| Conference | Holly et al., 2022 [665] | Gaining Impact with Mixed Reality in Industry – A Sustainable Approach | 2022 8th International Conference on Computer Technology Applications | No relation to SDGs |
| Journal | Kumar & Raghavendran, 2015 [666] | Gamification, the finer art: fostering creativity and employee engagement | Journal of Business Strategy | No relation to SDGs |
| Journal | Al-Mondhiry et al., 2022 [667] | Co-created Mobile Apps for Palliative Care Using Community-Partnered Participatory Research: Development and Usability Study | JMIR Formative Research | Not workplace-related |
| Journal | Armisen & Majchrzak, 2015 [668] | Tapping the innovative business potential of innovation contests | Business Horizons | Not workplace-related |
| Conference | Bhardwaj et al., 2020 [669] | Ikigailand: Gamified Urban Planning Experiences For Improved Participatory Planning. | IndiaHCI '20: Proceedings of the 11th Indian Conference on Human-Computer Interaction | Not workplace-related |
| Journal | Fernández & Ceacero-Moreno, 2021 [670] | Urban Sustainability and Natural Hazards Management; Designs Using Simulations | Sustainability | Not workplace-related |
| Journal | Hammedi et al., 2021 [321]. | The use of gamification mechanics to increase employee and user engagement in participative healthcare services | Journal of Service Management | Not workplace-related |

Table A.1: List of excluded full texts during the review on gamification for sustainable employee behavior.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Conference | Kobayashi et al., 2015 [671] | Motivating Multi-Generational Crowd Workers in Social-Purpose Work | Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing | Not workplace-related |
| Journal | Mokhtar et al., 2021 [672] | Applying serious game elements to enhance flood safety training management | Journal of Theoretical and Applied Information Technology | Not workplace-related |
| Journal | Negrușa et al., 2015 [673] | Exploring Gamification Techniques and Applications for Sustainable Tourism | Sustainability | Not workplace-related |
| Journal | Novak et al., 2018 [60] | Integrating behavioural change and gamified incentive modelling for stimulating water saving | Environmental Modelling & Software | Not workplace-related |
| Journal | Olszewski et al., 2018 [674] | Solving “Smart City” Transport Problems by Designing Carpooling Gamification Schemes with Multi-Agent Systems: The Case of the So-Called “Mordor of Warsaw” | Sensors | Not workplace-related |
| Conference | Contreras et al., 2019 [675] | Towards the Gamification of Assistive Technology for Professionals with Severe Impairments | 2019 International Conference on Virtual Reality and Visualization (ICVRV) | Not primarily gamification |
| Conference | Di Fuccio et al., 2020 [676] | Qualitative acceptance and co-design of an app aimed at improving emotional intelligence for precarious workers | Proceedings of the Second Symposium on Psychology-Based Technologies | Not primarily gamification |
| Conference | Gabele et al., 2021 [677] | Potentials of a web-based gamification guidance for knowledge transfer between research and industry | Extended Abstracts of the 2021 Annual Symposium on Computer-Human Interaction in Play | Not primarily gamification |

Table A.1: List of excluded full texts during the review on gamification for sustainable employee behavior.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Invernizzi et al., 2021 [678] | Children over "-enty,-rty,-fty": Gamification and autonomy as an environmental education leitmotif for "children of all ages" using a new workplace narrative | Journal of Physical Education and Sport | Not primarily gamification |
| Journal | Morton et al., 2020 [679] | Empowering and Engaging European building users for energy efficiency | Energy Research & Social Science | Not primarily gamification |
| Journal | Muro et al., 2022 [680] | The Third Half: A Pilot Study Using Evidence-Based Psychological Strategies to Promote Well-Being among Doctoral Students | International Journal of Environmental Research and Public Health | Not primarily gamification |
| Conference | Pacheco et al., 2018 [681] | Stepbox: A proposal of share economy transport service | 2018 13th Iberian Conference on Information Systems and Technologies (CISTI) | Not primarily gamification |
| Journal | Wallenburg & Bal, 2019 [682] | The gaming healthcare practitioner: How practices of datafication and gamification reconfigure care | Health Informatics Journal | Not primarily gamification |
| Conference | Zhang & Qin, 2021 [683] | InterRings: Towards Understanding Design Micro-games to Fit Daily Work Routine | Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems | Not primarily gamification |
| Conference | Al-Yafi & El-Masri, 2016 [684] | Gamification of e-Government services: A discussion of potential transformation | AMCIS 2016: Surfing the IT Innovation Wave - 22nd Americas Conference on Information Systems | Conceptual article |
| Journal | Araújo & Pestana, 2017 [685] | A framework for social well-being and skills management at the workplace | International Journal of Information Management | Conceptual article |
| Journal | Beaton, 2016 [686] | BUZZING—A Theory-Based Impact Evaluation Design | Evaluation Journal of Australasia | Conceptual article |

Table A.1: List of excluded full texts during the review on gamification for sustainable employee behavior.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Conference | Blom et al., 2019 [687] | Andromeda: A Personalised Crisis Management Training Toolkit | Games and Learning Alliance, GALA 2019 | Conceptual article |
| Conference | Cherinka et al., 2013 [688] | Emerging trends, technologies and approaches impacting innovation | IMETI 2013 - 6th International Multi-Conference on Engineering and Technological Innovation | Conceptual article |
| Journal | Clifford et al., 2014 [689] | Interactive Water Services: The WATERNOMICS Approach | Procedia Engineering | Conceptual article |
| Journal | Cudney et al., 2015 [690] | Engaging Healthcare Users through Gamification in Knowledge Sharing of Continuous Improvement in Healthcare | Procedia Manufacturing | Conceptual article |
| Conference | Ćwil & Bartnik, 2018 [691] | Supporting Energy Efficient Train Operation by Using Gamification to Motivate Train Drivers | Intersections in Simulation and Gaming, ISAGA SimTecT 2016 | Conceptual article |
| Journal | Dahdouh-Guebas et al., 2022 [692] | The Mangal Play: A serious game to experience multi-stakeholder decision-making in complex mangrove social-ecological systems | Frontiers in Marine Science | Conceptual article |
| Conference | Dorling & McCaffery, 2012 [693] | The Gamification of SPICE | Software Process Improvement and Capability Determination, SPICE 2012 | Conceptual article |
| Journal | Ferreira et al., 2018 [694] | An Energy Management Platform for Public Buildings | Electronics | Conceptual article |
| Conference | Fraternali et al., 2017 [695] | enCOMPASS — An integrative approach to behavioural change for energy saving | 2017 Global Internet of Things Summit (GIoTS) | Conceptual article |
| Journal | Gale et al., 2016 [696] | Health Worker Focused Distributed Simulation for Improving Capability of Health Systems in Liberia | Simulation in Healthcare: The Journal of the Society for Simulation in Healthcare | Conceptual article |

Table A.1: List of excluded full texts during the review on gamification for sustainable employee behavior.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Conference | Garcia et al., 2016 [697] | Waypass: A Gamified Self-Knowledge Quest for Teenagers | 2016 8th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES) | Conceptual article |
| Conference | Khurana et al., 2014 [698] | NeckGraffe | CHI '14 Extended Abstracts on Human Factors in Computing Systems | Conceptual article |
| Conference | Koivisto et al., 2017 [699] | Possible benefits of gamification for improving surgical patients' quality of care | 1st International GamiFIN Conference, GamiFIN 2017 | Conceptual article |
| Conference | Korn, 2012 [700] | Industrial playgrounds | Proceedings of the 4th ACM SIGCHI symposium on Engineering interactive computing systems - EICS '12 | Conceptual article |
| Conference | Kotsopoulos et al., 2017 [80] | Effecting employee energy conservation behaviour at the workplace by utilising gamification | Proceedings of the 25th European Conference on Information Systems, ECIS 2017 | Conceptual article |
| Journal | Laine et al., 2020 [477] | A Distributed Multiplayer Game to Promote Active Transport at Workplaces: User-Centered Design, Implementation, and Lessons Learned | IEEE Transactions on Games | Conceptual article |
| Journal | Levy, 2012 [701] | Get in the game: applying gamification to on-the-job safety. | Occupational health & safety | Conceptual article |

Table A.1: List of excluded full texts during the review on gamification for sustainable employee behavior.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Conference | Mosashvili et al., 2019 [702] | Digital Games for Effective Teaching Models of Ecotourism | 2019 International Conference on Information and Telecommunication Technologies and Radio Electronics (UkrMiCo) | Conceptual article |
| Conference | Mutombo et al., 2021 [703] | An Innovative Virtual Learning Environment to Enhance Age-Friendly Cultural Competencies | 2021 IEEE 45th Annual Computers, Software, and Applications Conference (COMPSAC) | Conceptual article |
| Conference | Nikolaidou et al., 2019 [704] | 'Inside the box': A cooperative game for co-creating energy efficient retail spaces | Building Simulation Conference Proceedings | Conceptual article |
| Conference | O'Connor et al., 2017 [705] | Developing gamified elements to influence positive behavioural change towards organisational energy efficiency | Proceedings of the 11th European Conference on Games Based Learning, ECGBL 2017 | Conceptual article |
| Journal | Padilla-Zea et al., 2020 [706] | Training on Social Economy Entrepreneurship | Journal of Information Technology Research | Conceptual article |
| Conference | Papaioannou et al., 2017 [707] | IoT-Enabled Gamification for Energy Conservation in Public Buildings | 2017 Global Internet of Things Summit (GIoTS) | Conceptual article |
| Conference | Papaioannou et al., 2018 [708] | A sensor-enabled rule engine for changing energy-wasting behaviours in public buildings | 2018 IEEE International Energy Conference (ENERGYCON) | Conceptual article |
| Journal | Papaioannou et al., 2018 [709] | An IoT-Based Gamified Approach for Reducing Occupants' Energy Wastage in Public Buildings | Sensors | Conceptual article |
| Journal | Papamichael et al., 2022 [710] | Unified waste metrics: A gamified tool in next-generation strategic planning | Science of The Total Environment | Conceptual article |

Table A.1: List of excluded full texts during the review on gamification for sustainable employee behavior.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Patriarca et al., 2019 [711] | Serious games for industrial safety: An approach for developing resilience early warning indicators | Safety Science | Conceptual article |
| Journal | Pinheiro et al., 2015 [712] | Gamification to expand awareness about stress and its impacts within companies gamification eustress x distress | International Workshop on Gamification in Health: gHealth 2015 | Conceptual article |
| Conference | Pogrebtsova et al., 2017 [713] | Using technology to boost employee wellbeing? How gamification can help or hinder results | 2017 Positive Gaming: Workshop on Gamification and Games for Wellbeing, PGW 2017 | Conceptual article |
| Journal | Potente et al., 2013 [714] | Gamification in Management Decisions: Judging Global Production Networks in a Cyber-Physical Way | Advanced Materials Research | Conceptual article |
| Journal | Prakash & Manchanda, 2021 [715] | Designing a comprehensive gamification model and pertinence in organisational context to achieve sustainability | Cogent Business & Management | Conceptual article |
| Conference | Rumsamrong & Chiou, 2021 [716] | An Overview of Gamification in Conflict Resolution and Complex Problems Using Scaled Down Arenas in Areas of Contention | 2021 IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE) | Conceptual article |
| Journal | Shpakova et al., 2020 [232] | Gamifying the process of innovating | Innovation | Conceptual article |
| Conference | Stevens, 2013 [717] | How gamification and behavior science can drive social change one employee at a time | Design, User Experience, and Usability. Health, Learning, Playing, Cultural, and Cross-Cultural User Experience. DUXU 2013. Lecture Notes in Computer Science | Conceptual article |

Table A.1: List of excluded full texts during the review on gamification for sustainable employee behavior.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Suppan et al., 2021 [325] | A Serious Game Designed to Promote Safe Behaviors Among Health Care Workers During the COVID-19 Pandemic: Development of "Escape COVID-19" | JMIR Serious Games | Conceptual article |
| Conference | Zinke-Wehlmann & Friedrich, 2019 [718] | Commute Green! The Potential of Enterprise Social Networks for Ecological Mobility Concepts | IFIP Advances in Information and Communication Technology | Conceptual article |
| Conference | Chui & Wai, 2015 [719] | Gamification: A novel approach for facilities manager to foster energy-saving behaviour | Proceedings of the 25th International Business Information Management Association Conference - Innovation Vision 2020: From Regional Development Sustainability to Global Economic Growth, IBIMA 2015 | Unaccessible |
| Conference | Elbæk et al., 2018 [720] | Designing an interactive wall for movement: For-and with-intellectual disabled people | Proceedings of the European Conference on Games-based Learning | Unaccessible |
| Journal | Erten et al., 2022 [721] | The role of virtual and augmented reality in occupational health and safety training of employees in PV power systems and evaluation with a sustainability perspective | Journal of Cleaner Production | Unaccessible |
| Conference | Göbel et al., 2019 [722] | SG4Mobility: Educational Game for Environment-Friendly Mobility Behaviour | Proceedings of the 12th European Conference on Game Based Learning | Unaccessible |
| Conference | Girdauskiene et al., 2020 [723] | Linkage Between Gamification and Moral Organisational Climate | Advances in Intelligent Systems and Computing | Unaccessible |

Table A.1: List of excluded full texts during the review on gamification for sustainable employee behavior.

| Type | Authors | Title | Journal | Annotation |
| --- | --- | --- | --- | --- |
| Journal | Gurbuz & Celik, 2022 [724] | A preliminary design of a 3D maritime gamified mentoring platform to support tanker pre-vetting inspection training: 'Maritime Gamentor' | Ships and Offshore Structures | Unaccessible |
| Journal | Niveditha, 2022 [362] | Key in socially driven game dynamics, open the doors of agility - an empirical study on gamification and employee agility | Behaviour & Information Technology | Unaccessible |
| Journal | von Barnekow et al., 2017 [725] | Can 3D Gamified Simulations Be Valid Vocational Training Tools for Persons with Intellectual Disability? | Methods of Information in Medicine | Unaccessible |
| Conference | Weerasekara & Smedberg, 2022 [726] | Felix The Digibud: Unveiling The Design of an ICT-Supported Intervention for Occupational Stress Management | 15th International Conference on ICT, Society and Human Beings, ICT 2022 | Unaccessible |

B

# Theoretical Foundations

## B.1 List of Excluded Full-Texts

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Beard-Gunter et al., 2019 [727] | TQM, games design and the implications of integration in Industry 4.0 systems | International Journal of Quality and Service Sciences | CA: No repeatability. Inclusion criteria not reported, final sample not reported. |
| Journal | Osatuyi et al., 2018 [728] | Systematic review of gamification research in is education: A multi-method approach | Communications of the Association for Information Systems | CA: No repeatability. Search strings ambiguous, Inclusion criteria not provided. |
| Journal | Ahmad et al., 2015 [729] | An analysis of educational games design frameworks from software engineering perspective | Journal of Information and Communication Technology | CA: No repeatability. Search strings not provided, inclusion criteria not provided |
| Journal | Boyle et al., 2011 [730] | The role of psychology in understanding the impact of computer games | Entertainment Computing | CA: No repeatability. Search strings not provided, no systematic review |
| Journal | Marini et al., 2018 [731] | Socio-psychological perspectives on the potential for serious games to promote transcendental values in IWRM decision-making | Water (Switzerland) | CA: No repeatability. Search strings not provided, results not provided |
| Journal | Helf & Hlavacs, 2016 [732] | Apps for life change: Critical review and solution directions | Entertainment Computing | CA: Search strategy missing |
| Journal | Ahmed & Sutton, 2017 [733] | Gamification, serious games, simulations, and immersive learning environments in knowledge management initiatives | World Journal of Science, Technology and Sustainable Development | Introduction to Special Issue |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Rapp et al., 2019 [734] | Strengthening gamification studies: Current trends and future opportunities of gamification research | International Journal of Human Computer Studies | Introduction to Special Issue |
| Journal | Wünderlich et al., 2020 [735] | The great game of business: Advancing knowledge on gamification in business contexts | Journal of Business Research | Introduction to Special Issue |
| Journal | Abdul Jabbar & Felicia, 2015 [736] | Gameplay Engagement and Learning in Game-Based Learning: A Systematic Review | Review of Educational Research | No analysis of theories |
| Journal | Akl et al., 2013 [737] | Educational games for health professionals | Cochrane Database of Systematic Reviews | No analysis of theories |
| Journal | Alahäivälä & Oinas-Kukkonen, 2016 [738] | Understanding persuasion contexts in health gamification: A systematic analysis of gamified health behavior change support systems literature | International Journal of Medical Informatics | No analysis of theories |
| Journal | Alanne, 2016 [739] | An overview of game-based learning in building services engineering education | European Journal of Engineering Education | No analysis of theories |
| Conference | Alla & Nafil, 2019 [740] | Gamification in IoT application: A systematic mapping study | Procedia Computer Science | No analysis of theories |
| Journal | Alomari et al., 2019 [741] | The role of gamification techniques in promoting student learning: A review and synthesis | Journal of Information Technology Education: Research | No analysis of theories |
| Journal | Anderson et al., 2010 [742] | Developing serious games for cultural heritage: a state-of-the-art review | Virtual Reality | No analysis of theories |
| Journal | Andersson et al., 2018 [56] | Promoting sustainable travel behaviour through the use of smartphone applications: A review and development of a conceptual model | Travel Behaviour and Society | No analysis of theories |
| Journal | Antonaci et al., 2019 [743] | The effects of gamification in online learning environments: A systematic literature review | Informatics | No analysis of theories |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Bai et al., 2020 [267] | Does gamification improve student learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts | Educational Research Review | No analysis of theories |
| Journal | Baptista & Oliveira, 2019 [744] | Gamification and serious games: A literature meta-analysis and integrative model | Computers in Human Behavior | No analysis of theories |
| Journal | Behl et al., 2020 [745] | Gamification in E- Commerce | Journal of Electronic Commerce in Organizations | No analysis of theories |
| Journal | Bodnar et al., 2016 [746] | Engineers at Play: Games as Teaching Tools for Undergraduate Engineering Students | Journal of Engineering Education | No analysis of theories |
| Journal | Bossen et al., 2020 [747] | Effectiveness of Serious Games to Increase Physical Activity in Children with a Chronic Disease: Systematic Review with Meta-Analysis | Journal of Medical Internet Research | No analysis of theories |
| Journal | Caballero-Hernández et al., 2017 [748] | Skill assessment in learning experiences based on serious games: A Systematic Mapping Study | Computers and Education | No analysis of theories |
| Journal | Calderón & Ruiz, 2015 [749] | A systematic literature review on serious games evaluation: An application to software project management | Computers and Education | No analysis of theories |
| Journal | Calderón et al., 2018 [750] | A multivocal literature review on serious games for software process standards education | Computer Standards and Interfaces | No analysis of theories |
| Journal | Coleman & Money, 2020 [751] | Student-centred digital game–based learning: a conceptual framework and survey of the state of the art | Higher Education | No analysis of theories |
| Journal | Collado-Mateo et al., 2018 [752] | Effect of exergames on musculoskeletal pain: A systematic review and meta-analysis | Scandinavian Journal of Medicine and Science in Sports | No analysis of theories |
| Journal | Connolly et al., 2012 [264] | A systematic literature review of empirical evidence on computer games and serious games | Computers and Education | No analysis of theories |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Cordero-Brito & Mena, 2020 [753] | Gamification and Its Application in the Social Environment: A Tool for Shaping Behaviour | Journal of Information Technology Research | No analysis of theories |
| Journal | Darejeh & Salim, 2016 [229] | Gamification Solutions to Enhance Software User Engagement—A Systematic Review | International Journal of Human-Computer Interaction | No analysis of theories |
| Journal | Dehghanzadeh et al., 2019 [754] | Using gamification to support learning English as a second language: a systematic review | Computer Assisted Language Learning | No analysis of theories |
| Journal | De la Hera Conde-Pumpido, 2017 [755] | Persuasive Gaming: Identifying the different types of persuasion through games | International Journal of Serious Games | No analysis of theories |
| Journal | den Haan & van der Voort, 2018 [756] | On evaluating social learning outcomes of serious games to collaboratively address sustainability problems: A literature review | Sustainability (Switzerland) | No analysis of theories |
| Journal | Derksen et al., 2020 [757] | Serious games for smoking prevention and cessation: A systematic review of game elements and game effects | Journal of the American Medical Informatics Association | No analysis of theories |
| Journal | DeSmet et al., 2015 [758] | A Systematic Review and Meta-analysis of Interventions for Sexual Health Promotion Involving Serious Digital Games | Games for Health Journal | No analysis of theories |
| Journal | De Vette et al., 2015 [759] | Engaging Elderly People in Telemedicine Through Gamification | JMIR Serious Games | No analysis of theories |
| Journal | De Wit-Zuurendonk & Oei, 2011 [760] | Serious gaming in women's health care | BJOG: An International Journal of Obstetrics and Gynaecology | No analysis of theories |
| Journal | Dias et al., 2018 [761] | Gamification and serious games in depression care: A systematic mapping study | Telematics and Informatics | No analysis of theories |
| Journal | Dicheva et al., 2015 [484] | Gamification in education: A systematic mapping study | Educational Technology and Society | No analysis of theories |
| Journal | Drummond et al., 2017 [762] | A systematic review of serious games in asthma education | Pediatric Allergy and Immunology | No analysis of theories |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Edwards et al., 2019 [763] | Tools for adaptive governance for complex social-ecological systems: A review of role-playing-games as serious games at the community-policy interface | Environmental Research Letters | No analysis of theories |
| Journal | Eichenberg & Schott, 2017 [764] | Serious Games for Psychotherapy: A Systematic Review | Games for Health Journal | No analysis of theories |
| Journal | Farrington, 2011 [765] | From the research: Myths worth dispelling: Seriously, the game is up | Performance Improvement Quarterly | No analysis of theories |
| Journal | Feng et al., 2018 [766] | Immersive virtual reality serious games for evacuation training and research: A systematic literature review | Computers and Education | No analysis of theories |
| Journal | Fleming et al., 2014 [767] | Serious games for the treatment or prevention of depression: A systematic review | Spanish Journal of Clinical Psychology | No analysis of theories |
| Journal | Fleming et al., 2017 [768] | Serious games and gamification for mental health: Current status and promising directions | Frontiers in Psychiatry | No analysis of theories |
| Journal | Flood et al., 2018 [769] | Adaptive and interactive climate futures: Systematic review of 'serious games' for engagement and decision-making | Environmental Research Letters | No analysis of theories |
| Journal | Fox et al., 2018 [770] | Simulations in Entrepreneurship Education: Serious Games and Learning Through Play | Entrepreneurship Education and Pedagogy | No analysis of theories |
| Journal | Garcia et al., 2020 [771] | The effects of game-based learning in the acquisition of "soft skills" on undergraduate software engineering courses: A systematic literature review | Computer Applications in Engineering Education | No analysis of theories |
| Journal | Gauthier et al., 2019 [772] | Board Games for Health: A Systematic Literature Review and Meta-Analysis | Games for Health Journal | No analysis of theories |
| Journal | Gentry et al., 2019 [773] | Serious gaming and gamification education in health professions: systematic review | Journal of Medical Internet Research | No analysis of theories |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Girard et al., 2013 [774] | Serious games as new educational tools: How effective are they? A meta-analysis of recent studies | Journal of Computer Assisted Learning | No analysis of theories |
| Journal | Gorbanev et al., 2018 [775] | A systematic review of serious games in medical education: quality of evidence and pedagogical strategy | Medical Education Online | No analysis of theories |
| Journal | Graafland et al., 2012 [776] | Systematic review of serious games for medical education and surgical skills training | British Journal of Surgery | No analysis of theories |
| Journal | Hainey et al., 2016 [777] | A systematic literature review of games-based learning empirical evidence in primary education | Computers and Education | No analysis of theories |
| Journal | Hallinger & Wang, 2020 [778] | Analyzing the intellectual structure of research on simulation-based learning in management education, 1960-2019: A bibliometric review | The International Journal of Management Education | No analysis of theories |
| Journal | Hassan & Hamari, 2020 [779] | Gameful civic engagement: A review of the literature on gamification of e-participation | Government Information Quarterly | No analysis of theories |
| Journal | Hinton et al., 2019 [780] | Enterprise gamification systems and employment legislation: a systematic literature review | Australasian Journal of Information Systems | No analysis of theories |
| Journal | Hung et al., 2018 [781] | A scoping review of research on digital game-based language learning | Computers and Education | No analysis of theories |
| Journal | Hussein et al., 2019 [782] | Effects of Digital Game-Based Learning on Elementary Science Learning: A Systematic Review | IEEE Access | No analysis of theories |
| Journal | Indriasari et al., 2020 [783] | Gamification of student peer review in education: A systematic literature review | Education and Information Technologies | No analysis of theories |
| Journal | Johnson et al., 2016 [784] | Gamification for health and wellbeing: A systematic review of the literature | Internet Interventions | No analysis of theories |
| Journal | Johnson et al., 2017 [54] | Gamification and serious games within the domain of domestic energy consumption: A systematic review | Renewable and Sustainable Energy Reviews | No analysis of theories |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Kangas et al., 2017 [785] | A qualitative literature review of educational games in the classroom: the teacher's pedagogical activities | Teachers and Teaching: Theory and Practice | No analysis of theories |
| Journal | Kasurinen & Knutas, 2018 [52] | Publication trends in gamification: A systematic mapping study | Computer Science Review | No analysis of theories |
| Journal | Keusch & Zhang, 2017 [786] | A Review of Issues in Gamified Surveys | Social Science Computer Review | No analysis of theories |
| Journal | Kinross, 2018 [787] | Precision gaming for health: Computer games as digital medicine | Methods | No analysis of theories |
| Journal | Koh, 2020 [788] | A Qualitative Meta-Analysis on the Use of Serious Games to Support Learners with Intellectual and Developmental Disabilities: What We Know, What We Need to Know and What We Can Do | International Journal of Disability, Development and Education | No analysis of theories |
| Journal | Koivisto & Hamari, 2019 [48] | The rise of motivational information systems: A review of gamification research | International Journal of Information Management | No analysis of theories |
| Journal | Lai & Bower, 2020 [789] | Evaluation of technology use in education: Findings from a critical analysis of systematic literature reviews | Journal of Computer Assisted Learning | No analysis of theories |
| Journal | Laine & Lindberg, 2020 [477] | Designing Engaging Games for Education: A Systematic Literature Review on Game Motivators and Design Principles | IEEE Transactions on Learning Technologies | No analysis of theories |
| Journal | Lamb et al., 2018 [263] | A meta-analysis with examination of moderators of student cognition, affect, and learning outcomes while using serious educational games, serious games, and simulations | Computers in Human Behavior | No analysis of theories |
| Journal | Lämsä et al., 2018 [512] | Games for enhancing basic reading and maths skills: A systematic review of educational game design in supporting learning by people with learning disabilities | British Journal of Educational Technology | No analysis of theories |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Landers, 2014 [120] | Developing a Theory of Gamified Learning: Linking Serious Games and Gamification of Learning | Simulation and Gaming | No analysis of theories |
| Journal | Lau et al., 2017 [790] | Serious Games for Mental Health: Are They Accessible, Feasible, and Effective? A Systematic Review and Meta-analysis. | Frontiers in psychiatry | No analysis of theories |
| Journal | Lin et al., 2013 [791] | Designing a web-based behavior motivation tool for healthcare compliance | Human Factors and Ergonomics In Manufacturing | No analysis of theories |
| Journal | Lopes et al., 2018 [792] | Games Used With Serious Purposes: A Systematic Review of Interventions in Patients With Cerebral Palsy. | Frontiers in psychology | No analysis of theories |
| Journal | Magista et al., 2018 [793] | A review of the applicability of gamification and game-based learning to improve household-level waste management practices among schoolchildren | International Journal of Technology | No analysis of theories |
| Journal | Maheu-Cadotte et al., 2018 [794] | Effectiveness of serious games and impact of design elements on engagement and educational outcomes in healthcare professionals and students: A systematic review and meta-Analysis protocol | BMJ Open | No analysis of theories |
| Journal | Marlow et al., 2016 [795] | Eliciting teamwork with game attributes: A systematic review and research agenda | Computers in Human Behavior | No analysis of theories |
| Journal | Martinho et al., 2020 [796] | A systematic review of gamification techniques applied to elderly care | Artificial Intelligence Review | No analysis of theories |
| Journal | Morganti et al., 2017 [55] | Gaming for Earth: Serious games and gamification to engage consumers in pro-environmental behaviours for energy efficiency | Energy Research and Social Science | No analysis of theories |
| Journal | Morschheuser et al., 2018 [123] | How to design gamification? A method for engineering gamified software | Information and Software Technology | No analysis of theories |
| Journal | Morschheuser et al., 2017 [553] | Gamified crowdsourcing: Conceptualization, literature review, and future agenda | International Journal of Human Computer Studies | No analysis of theories |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Obaid et al., 2020 [282] | Gamification for Recruitment and Job Training: Model, Taxonomy, and Challenges | IEEE Access | No analysis of theories |
| Journal | O'Loughlin et al., 2020 [797] | Exergaming in Youth and Young Adults: A Narrative Overview | Games for Health Journal | No analysis of theories |
| Journal | Pathak et al., 2021 [798] | A study on Systematic review of Gamification in Education Sector | Journal of Contemporary Issues in Business and Management | No analysis of theories |
| Journal | Perttula et al., 2017 [799] | Flow experience in game based learning – a systematic literature review | International Journal of Serious Games | No analysis of theories |
| Journal | Petri & von Wangenheim, 2016 [800] | How to evaluate educational games: A systematic literature review | Journal of Universal Computer Science | No analysis of theories |
| Journal | Pimentel et al., 2020 [801] | Game-Based Learning Interventions to Foster Cross-Cultural Care Training: A Scoping Review | Games for Health Journal | No analysis of theories |
| Journal | Ravyse et al., 2017 [802] | Success factors for serious games to enhance learning: a systematic review | Virtual Reality | No analysis of theories |
| Journal | Riopel et al., 2019 [803] | Impact of serious games on science learning achievement compared with more conventional instruction: an overview and a meta-analysis | Studies in Science Education | No analysis of theories |
| Journal | Rodrigues et al., 2019 [804] | Main gamification concepts: A systematic mapping study | Heliyon | No analysis of theories |
| Journal | Roth et al., 2015 [805] | The ludic drive as innovation driver: Introduction to the gamification of innovation | Creativity and Innovation Management | No analysis of theories |
| Journal | Rumeser & Emsley, 2018 [806] | A systematic review of project management serious games: Identifying gaps, trends and directions for future research | Journal of Modern Project Management | No analysis of theories |
| Journal | Sailer & Homner, 2020 [807] | The Gamification of Learning: a Meta-analysis | Educational Psychology Review | No analysis of theories |
| Journal | Santamaría et al., 2011 [808] | Serious games as additional psychological support: A review of the literature | Journal of Cybertherapy and Rehabilitation | No analysis of theories |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Sardi et al., 2017 [809] | A systematic review of gamification in e-Health | Journal of Biomedical Informatics | No analysis of theories |
| Journal | Schmidt & De Marchi, 2017 [810] | Usability evaluation methods for mobile serious games applied to health: a systematic review | Universal Access in the Information Society | No analysis of theories |
| Journal | Sera & Wheeler, 2017 [811] | Game on: The gamification of the pharmacy classroom | Currents in Pharmacy Teaching and Learning | No analysis of theories |
| Conference | Shoukry & Göbel, 2020 [812] | Reasons and Responses: A Multimodal Serious Games Evaluation Framework | IEEE Transactions on Emerging Topics in Computing | No analysis of theories |
| Journal | Sipiyaruk et al., 2018 [813] | A rapid review of serious games: From healthcare education to dental education | European Journal of Dental Education | No analysis of theories |
| Journal | Stanitsas et al., 2019 [814] | Facilitating sustainability transition through serious games: A systematic literature review | Journal of Cleaner Production | No analysis of theories |
| Journal | Subhash & Cudney, 2018 [815] | Gamified learning in higher education: A systematic review of the literature | Computers in Human Behavior | No analysis of theories |
| Journal | Tăut et al., 2017 [816] | Play seriously: Effectiveness of serious games and their features in motor rehabilitation. A meta-analysis | NeuroRehabilitation | No analysis of theories |
| Journal | Taylor et al., 2012 [817] | The Coaching Cycle: A Coaching-by-Gaming Approach in Serious Games | Simulation and Gaming | No analysis of theories |
| Journal | Theng et al., 2015 [818] | The Use of Videogames, Gamification, and Virtual Environments in the Self-Management of Diabetes: A Systematic Review of Evidence | Games for Health Journal | No analysis of theories |
| Journal | Tsai & Fan, 2013 [819] | Research trends in game-based learning research in online learning environments: A review of studies published in SSCI-indexed journals from 2003 to 2012 | British Journal of Educational Technology | No analysis of theories |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Tsikinas & Xinogalos, 2019 [820] | Studying the effects of computer serious games on people with intellectual disabilities or autism spectrum disorder: A systematic literature review | Journal of Computer Assisted Learning | No analysis of theories |
| Journal | Valladares-Rodríguez et al., 2016 [821] | Trends on the application of serious games to neuropsychological evaluation: A scoping review | Journal of Biomedical Informatics | No analysis of theories |
| Journal | Wang et al., 2016 [822] | A systematic review of serious games in training: Health care professionals | Simulation in Healthcare | No analysis of theories |
| Journal | Wanick & Bui, 2019 [823] | Gamification in Management: a systematic review and research directions | International Journal of Serious Games | No analysis of theories |
| Journal | Warmelink et al., 2020 [541] | Gamification of production and logistics operations: Status quo and future directions | Journal of Business Research | No analysis of theories |
| Journal | Wouters et al., 2013 [824] | A meta-analysis of the cognitive and motivational effects of serious games | Journal of Educational Psychology | No analysis of theories |
| Journal | Xu et al., 2017 [825] | Serious games and the gamification of tourism | Tourism Management | No analysis of theories |
| Journal | Yáñez-Gómez et al., 2017 [826] | Academic methods for usability evaluation of serious games: a systematic review | Multimedia Tools and Applications | No analysis of theories |
| Journal | Yıldırım & Şen, 2019 [827] | The effects of gamification on students' academic achievement: a meta-analysis study | Interactive Learning Environments | No analysis of theories |
| Journal | Yu, 2019 [828] | A Meta-Analysis of Use of Serious Games in Education over a Decade | International Journal of Computer Games Technology | No analysis of theories |
| Journal | Zhou et al., 2020 [829] | A Meta-analysis of Narrative Game-based Interventions for Promoting Healthy Behaviors | Journal of Health Communication | No analysis of theories |
| Journal | Zou et al., 2021 [830] | Digital game-based vocabulary learning: Where are we and where are we going? | Computer Assisted Language Learning | No analysis of theories |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Edwards et al., 2016 [831] | Gamification for health promotion: systematic review of behaviour change techniques in smartphone apps | BMJ open | No review on literature |
| Journal | Aparicio et al., 2019 [832] | Gamification: A key determinant of massive open online course (MOOC) success | Information and Management | Not a review |
| Journal | Afyouni et al., 2017 [833] | A therapy-driven gamification framework for hand rehabilitation | User Modeling and User-Adapted Interaction | Not a review |
| Journal | Bíró, 2014 [834] | Didactics 2.0: A Pedagogical Analysis of Gamification Theory from a Comparative Perspective with a Special View to the Components of Learning | Procedia - Social and Behavioral Sciences | Not a review |
| Journal | Cardador et al., 2017 [835] | A theory of work gamification: Something old, something new, something borrowed, something cool? | Human Resource Management Review | Not a review |
| Journal | Carvalho et al., 2015 [836] | An activity theory-based model for serious games analysis and conceptual design | Computers and Education | Not a review |
| Journal | Chen, 2019 [481] | Exploring Design Guidelines of Using User-Centered Design in Gamification Development: A Delphi Study | International Journal of Human-Computer Interaction | Not a review |
| Journal | Conway, 2014 [837] | Zombification?: Gamification, motivation, and the user | Journal of Gaming and Virtual Worlds | Not a review |
| Journal | D'Aprile et al., 2015 [838] | Social, constructivist and informal learning processes: Together on the edge for designing digital game-based learning environments | Journal of E-Learning and Knowledge Society | Not a review |
| Journal | Gunter et al., 2008 [839] | Taking educational games seriously: Using the RETAIN model to design endogenous fantasy into standalone educational games | Educational Technology Research and Development | Not a review |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Huang & Hew, 2018 [840] | Implementing a theory-driven gamification model in higher education flipped courses: Effects on out-of-class activity completion and quality of artifacts | Computers and Education | Not a review |
| Journal | Kam & Umar, 2018 [841] | Fostering Authentic Learning Motivations through Gamification: a Self-Determination Theory (SDT) Approach | Journal of Engineering Science and Technology | Not a review |
| Journal | Landers et al., 2019 [109] | Defining gameful experience as a psychological state caused by gameplay: Replacing the term 'Gamefulness' with three distinct constructs | International Journal of Human Computer Studies | Not a review |
| Journal | Liu et al., 2017 [124] | Toward Meaningful Engagement : a Framework for Design and Research of Gamified Information Systems | MIS Quarterly | Not a review |
| Journal | Murillo-Zamorano et al., 2020 [842] | Gamified crowdsourcing in higher education: A theoretical framework and a case study | Thinking Skills and Creativity | Not a review |
| Journal | Nacke & Deterding, 2017 [111] | The maturing of gamification research | Computers in Human Behavior | Not a review |
| Journal | Perryer et al., 2016 [843] | Enhancing workplace motivation through gamification: Transferrable lessons from pedagogy | International Journal of Management Education | Not a review |
| Journal | Plass et al., 2015 [258] | Foundations of Game-Based Learning | Educational Psychologist | Not a review |
| Journal | Procci et al., 2014 [844] | Opening Cinematics: Their Cost-Effectiveness in Serious Games | Simulation and Gaming | Not a review |
| Journal | Rapp, 2017 [482] | Drawing inspiration from world of warcraft: Gamification design elements for behavior change technologies | Interacting with Computers | Not a review |
| Journal | Rodrigues et al., 2016 [845] | Playing seriously - How gamification and social cues influence bank customers to use gamified e-business applications | Computers in Human Behavior | Not a review |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Conference | Songer & Miyata, 2014 [846] | A playful affordances model for gameful learning | ACM International Conference Proceeding Series | Not a review |
| Conference | Suttie et al., 2012 [847] | In pursuit of a 'serious games mechanics' : A theoretical framework to analyse relationships between 'game' and 'pedagogical aspects' of serious games | Procedia Computer Science | Not a review |
| Journal | Tahir & Wang, 2020 [848] | Codifying Game-Based Learning: Development and Application of LEAGUE Framework for Learning Games | The Electronic Journal of e-Learning | Not a review |
| Journal | Turkay et al., 2014 [849] | Toward Understanding the Potential of Games for Learning: Learning Theory, Game Design Characteristics, and Situating Video Games in Classrooms | Computers in the Schools | Not a review |
| Journal | Brancato et al., 2020 [850] | Behavioral Psychological based on Development of Serious Digital Games for Individuals with Autistic Spectrum Disorder: Systematic Review | Humanidades & Inovacao | Not english |
| Journal | Christianini et al., 2016 [851] | Gamified Systems Development focused on Edutertainment and Player: an Analysis of Bartle and Marczewski Archetypes | Revista Ibero-Americana de Estudos em Educação | Not english |
| Journal | Contreras, 2020 [852] | Gamification in Educational Contexts: Analysis of Its Application in a Distance Public Accounting Program | Revista Universidad Empressa | Not english |
| Journal | Kankanamge et al., 2020 [853] | How can gamification be incorporated into disaster emergency planning? A systematic review of the literature | International Journal of Disaster Resilience in the Built Environment | Unaccessible |
| Journal | Kleiman et al., 2020 [854] | A Systematic Literature Review on the Use of Games for Attitude Change: Searching for Factors Influencing Civil Servants' Attitudes | International Journal of Electronic Government Research | Unaccessible |

Table B.1: List of excluded full texts during the review on theoretical foundations in gamification research.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Noorbehbahani et al., 2019 [855] | A systematic mapping study on gamification applied to e-marketing | Journal of Research in Interactive Marketing | Unaccessible |

## B.2 List of Theoretical Foundations and Coded Abbreviations

Table B.2: List of theoretical foundations and coded abbreviations used for the systematic review on theoretical foundations in gamification research.

| Abbreviation | Name | Abbreviation | Name |
|---|---|---|---|
| TPB | Theory of planned behavior | UDL | Universal design for learning |
| RT | Reinforcement theory | PPM | Presence pedagogy model |
| TRA | Theory of reasoned action | 7E | Eisenkraft's 7E instructional model |
| TTM | Transtheoretical model of behavior change | FSLS | Felder-Silverman learning style model |
| FBM | Fogg's behavior model | MPID | Merrill's principles of instruction design theory |
| RCT | Rational choice theory | TETEM | Technology-enhanced training effectiveness model |
| EDT | Ego depletion theory | SOLT | Social learning theory |
| PPROM | Parallel process model | MT | Malone's theory |
| TMB | Theory of meanings of behavior | SDT | Self-determination theory |
| KABM | Knowledge, attitude, behavior model | FT | Flow theory |
| SNETT | Social network theory | SE | Self-efficacy theory |
| AT | Activity theory | GS | Goal-setting theory |
| SCONT | Social conformity theory | CET | Cognitive evaluation theory |
| TAM | Technology acceptance model | OIT | Organismic integration theory |
| MDA | Mechanics, dynamics and aesthetics framework | FDT | Four drives theory |
| ISSM | Information systems success model | PAT | Person-artefact-task model |
| MDE | Mechanics, dynamics and emotions model | MHN | Maslow's hierarchy of needs |
| TIT | Theory of interactive technology | GOT | Achievement goal theory |
| MDF | Moral design framework | SCOMT | Social comparison theory |
| UTAUT | Unified theory of acceptance and use of technology | MSPN | Murray's secondary psychological needs |
| MGF | User-centered theoretical framework for meaningful gamification | TCMM | Transcontextual model of motivation |
| SCOGT | Social cognitive theory | HBM | Health belief model |
| ARCS | ACRS model | SR | Situational relevance theory |
| LGL | Lander's theory of gamified learning | CONTT | Control theory |
| CLT | Cognitive load theory | ELM | Elaboration likelihood model |
| SLT | Situated learning theory | TT | Taxation theory |
| CONLT | Constructivist learning theory | DIT | Diffusion of innovation theory |

Table B.2: List of theoretical foundations and coded abbreviations used for the systematic review on theoretical foundations in gamification research.

| Abbreviation | Name | Abbreviation | Name |
|---|---|---|---|
| SCTCD | Sociocultural theory of cognitive development | TOB | Theory of organisational behavior |
| MVP | Theory of motivation, volition and performance | BIG5 | Big five personality theory |
| MML | Multimedia learning theory | TRANST | Transportation theory |
| SHM | Sexual health model | UML | Unified modeling language |
| TDGDM | Theory-driven gamification design model | SI | Situational interest theory |
| EV | Expectancy-value theory | TGID | Theory of gamified instructional design |
| DGBL | Digital game-based learning | PP | Premack's principle |
| UCD | User-centered design | ELT | Experiential learning theory |
| STCD | Stage theory of cognitive development | CBL | Case-based learning |
| DLT | Discovery learning theory | PBL | Problem-based learning |
| UGT | Uses and gratifications theory | TMI | Theory of multiple intelligence |
| IM | Immersion theory | MMT | Mood management theory |
| ATT | Affect transfer theory | CT | Communication theory |
| TRME | Theory of realistic mathematics education | IMB | Information, motivation and behavior model |
| MRT | Middle-range theory of chronic illness | ALT | Adult learning theory |
| WICS | Wisdom, intelligence and creativity synthesized theory | PACT | Play, affect and creativity theory |
| TA | Theory of affordances | MM | Model model |
| MOT | Moran's theorem | GT | Guilford's structure of intellect |
| GGBL | Gee's game-based learning principles | IBL | Inquiry-based learning |
| WGF | Werbach's gamification framework | CDT | Cognitive dissonance theory |
| IML | Taxonomy of intrinsic motivations for learning | EMLT | Embodied learning |
| TML | Theory of motivation to learn | TEM | Tripartite enjoyment model |
| TP | Transformational play | SEM | Situative embodiment |
| EN | Enactivism | POE | Prediction-observation-explanation model |
| ITL | Interest theory of learning | CONSTR | Constructionism |
| SDDSM | Scientific discovery as dual search model | NCL | Narrative centered learning |
| GIS | Gagné's instruction strategies | BE | Behavioral economics |
| DTT | Dual-task training | SDL | Self-directed learning theory |
| BCT | Taxonomy of behavior change techniques | ATR | Attribution theory |
| DPT | Deliberate practice | TCONL | Theory of conditions for learning |
| ELAB | Elaboration theory | CA | Cognitive apprenticeship |
| ANT | Actor-network theory | DI | Direct instruction |
| PI | Programmed instruction | | |

## B.3 Coding Scheme

Table B.3: Coding scheme for the categorization of theoretical foundations used in research on gamification, serious games and game-based learning.

| Category | Description | Initial exemplary theories |
|---|---|---|
| Affect and motivation | Theoretical foundations related to the determinants or processes of motivation, valence (e.g. satisfaction, enjoyment, immersion, attitude) or arousal | Self-determination theory, flow theory |
| Behavior | Theoretical foundations related to the determinants of behavior or processes of behavior change | Theory of planned behavior, transtheoretical model of behavior change |
| Learning | Theoretical foundations related to cognitive processes and influence factors of learning (e.g. reasoning, problem-solving, creative thinking, knowledge acquisition) | Social learning theory, situated learning theory |

## B.4 Explanation of Theoretical Foundations

Table B.4: Detailed explanation of theoretical foundations, their origins, and their use in research on gamification and serious games.

| Theoretical foundation | Origin and core statements | Use in research on gamification |
|---|---|---|
| Theoretical foundations related to affect and motivation | | |
| Self-Determination Theory (SDT) | SDT has evolved over several decades as an organismic, dialectic meta-theory of human motivation [486]. It does not only describe motivation in quantity but also in quality, as it differentiates between amotivation and different types of extrinsic and intrinsic motivation [474]. These types of motivation are aligned on a continuum of relative autonomy, from fully controlled external regulation of behavior over introjected, identified, and integrated regulation to intrinsic regulation as the prototype of self-regulated behavior [486]. More autonomous forms of behavior regulation are connected to well-being and personal development. Moreover, motivation can become more autonomous through the process of integration, as described in Organismic Integration Theory, a sub-theory of SDT [112], [486]. According to SDT, three basic psychological needs – the need for competence, the need for autonomy, and the need for relatedness –form the basis of human motivation [474]. | Applications of SDT usually relate to the basic psychological needs. They aim either deriving implications for game design (e.g. [369], [496], [856]) or at measuring whether an intervention increases the perceived competence, relatedness and autonomy (e.g. [381]–[383]). |

Table B.4: Detailed explanation of theoretical foundations, their origins, and their use in research on gamification and serious games.

| Theoretical foundation | Origin and core statements | Use in research on gamification |
|---|---|---|
| Flow theory | Flow is a *"holistic sensation that people feel when they act with total involvement"* [330], p. 36. This mental state is characterized by intense concentration, merging of action and awareness, loss of self-consciousness and a distortion of temporal experience [392], [857]. The concept of flow is directly related to intrinsic motivation: when individuals are fully involved in an activity, they experience the activity as intrinsically rewarding, and pursue it for the sake of the activity itself rather than to achieve the ultimate goal [392]. To achieve flow, the opportunities for action must be balanced with the abilities of the actor [330], [494]. Additionally, clear objectives and immediate feedback support flow [392], [473]. | Flow is measured to evaluate gamified interventions and to draw implications for the relationship between flow and behavioral outcomes (e. g. [393], [394], [396], [858]). |
| ARCS model | Keller's ARCS model is a motivational model for instructional design based primarily on expectancy-value theory as presented by Porter & Lawler [397], which describes motivation as the result of a function of value – a person's preference for certain outcomes, e.g. based on psychological needs – and expectancy – a subjective probability of success [366]. These two factors are expanded to four: attention and relevance refer to the value category, and confidence and satisfaction belong to the expectancy side [117]. Satisfaction is related with outcome expectations, such as goals, whereas confidence refers to the personal belief in success, i.e. self-efficacy [352]. Keller postulates different teaching strategies for each of these four factors [117]. | The ARCS model is used pertinently for evaluating serious games in education (e. g. [415]–[418]), but it has also been applied to health-related serious games, for instance [859]. |
| Goal-setting theory | The core of goal-setting theory arose from the observation that difficult goals produce a higher level of performance than easy goals, and that specific difficult goals produce a higher level of performance than ambiguous difficult goals [331]. They do so through three motivational mechanisms of behavior (the direction, effort and persistence of behavior) and through influencing task-relevant knowledge [358], [374]. Furthermore, there are six moderators which influence the relationship between goals and performance: goal commitment, feedback, task complexity, situational constraints, personality, affect and ability. The concept of self-efficacy [352] is explicitly described as an enabler of goal commitment [358], [374]. | Scientists investigate if goals in game-based learning enhance performance [421] and put forward the hypothesis that e.g. leaderboards provide goals and immediate feedback, so that performance improves [419], [420]. |

Table B.4: Detailed explanation of theoretical foundations, their origins, and their use in research on gamification and serious games.

| Theoretical foundation | Origin and core statements | Use in research on gamification |
|---|---|---|
| Self-efficacy theory | Self-efficacy is a person's conviction that he or she can successfully execute the behavior which is required to achieve the outcomes [352]. Self-efficacy does not necessarily depend on the objective level of ability and is highly context-dependent, so it can vary considerably depending on circumstances [860]. However, perceived self-efficacy has a direct influence on people's choice of activities. It determines how much effort people will expend and how long they will persist if obstacles occur [359], which is why self-efficacy is highly relevant for motivation. Self-efficacy theory states that perceived self-efficacy can be influenced by four main sources of efficacy information: one's own performance accomplishments, vicarious experience (seeing others perform well), verbal persuasion and emotional arousal [359]. | Gamification studies examine whether game mechanics strengthen the transparency of performance in order increase self-efficacy [861], e.g. for reacting in emergencies [386], identifying cyber-security threads [387] and performing in learning tasks [388]. |
| Social comparison theory | The theory of social comparison processes states that people have a natural drive to evaluate their opinions and abilities [389]. Social comparisons allow people to check their own version of reality and serve as a basis for self-evaluation [862]. While Festinger [389] assumes an unidirectional drive for upward comparisons in abilities, later research led to the suggestion that people foremost try to achieve a positive self-evaluation [863]. Ultimately, the direction of social comparison processes and their outcome can have a lasting effect on self-esteem [864]. Empirical research has shown that several factors influence whether an upward comparison is perceived as motivating or discouraging, such as the possibility to make private comparisons, the perceived risk of exposing one's own inferiority to others, and the personal motive of self-improvement [390]. | Researchers investigate whether social comparisons, in form of leaderboards or elements of social status, have a positive or negative impact on motivation and performance (e.g. [391], [490]). |
| Achievement goal theory | Nicholls [414] first described that there are two types of achievement motivations in the pursuit of goals: ego involvement – or mastery goal orientation - and task involvement – or performance goal orientation. These orientations interact, meaning that each individual exhibits a mixture of these orientations with varying intensity [598]. Elliot and others added the dimension of avoidance, resulting in an achievement goal matrix with four goal orientations [194], [480]: the mastery-approach orientation, where the individual focuses on increasing competence, the mastery-avoidance orientation, where the individual works to avoid failure, the performance-approach orientation, where the individual seeks to demonstrate ability and self-esteem relative to others and the performance-avoidance orientation, where the individual strives to avoid being perceived as incompetent relative to peers [865]. | Scholars are considering achievement goal theory to investigate whether motivational effects of gamified elements differ according to the participants' goal orientation [866], [867] and if gamified interventions can be individualized to fit the user's goal orientation towards a particular task [422]. |

Table B.4: Detailed explanation of theoretical foundations, their origins, and their use in research on gamification and serious games.

| Theoretical foundation | Origin and core statements | Use in research on gamification |
|---|---|---|
| Theoretical foundations related to behavior | | |
| Theory of Reasoned Action (TRA) | The TRA, formulated by Ajzen and Fishbein, postulates that the actual behavior of an individual depends on its behavioral intention, which is again determined by two influence factors: the behavioral attitude and the subjective norm [164], [165]. Generally speaking, people intend to perform a behavior when they evaluate it positively and when they think that others expect them to perform it [134]. The behavioral attitude is based on behavioral beliefs towards the outcome of the behavior in question (positive or negative), while the subjective norm depends on normative beliefs towards the expectations of important peers [134]. | TRA constitutes the ground theory for the Technology Acceptance Model (TAM), so most studies use both frameworks together to evaluate the acceptance and actual usage of gamified systems (e.g. [429], [868]–[870]). |
| Theory of Planned Behavior (TPB) | The TPB is a further development of the TRA. It differs from the original TRA in terms of perceived behavioral control, which is added as determinant for behavioral intention [166]. While the objective control over the behavior is not always measurable, people tend to have a subjective belief towards their capability to perform a certain behavior [166], [167]. This control belief is closely related to Bandura's concept of self-efficacy [352]: both are concerned with the perceived ability to perform a behavior [426]. | The TPB is used as a theoretical model to evaluate whether gamification influences the determinants and the intention itself, such as the intention to adopt solar energy [427], to choose sustainable means of transport [56] or to purchase [428]. |
| Technology Acceptance Model (TAM) | The TAM is an adaption of the TRA tailored to the user acceptance of information systems. In particular, TAM postulates that behavioral attitude, which in turn influences the behavioral intention to use the system, depends on two behavioral beliefs: perceived usefulness and perceived ease of use [118]. The importance of perceived usefulness is underpinned by the principal assumptions from expectancy theory [871]. On the other hand, self-efficacy theory [352] and research on the diffusion of innovations [872] support the importance of ease of use for the acceptance of technology. Finally, cost-benefit paradigms from behavioral decision theory [873] as well as the channel disposition model [874] and research on the evaluation of information reports [875] also suggest the dualistic importance of both factors. | TAM is applied to measure the perceived usefulness and the perceived ease of use and their influence on attitude, behavioral intent and behavioral outcomes (e. g. [429]–[431]) |

Table B.4: Detailed explanation of theoretical foundations, their origins, and their use in research on gamification and serious games.

| Theoretical foundation | Origin and core statements | Use in research on gamification |
|---|---|---|
| Reinforcement theory | Reinforcement theory is the most prominent example of radical behaviorism, a philosophy of science that treats behavior as an observable subject, apart from internal psychological processes [423]. It concentrates on the stimuli presented and distinguishes between reinforcement and punishment: positive reinforcement presents or adds positive stimuli, such as rewards, while negative reinforcement removes discomforting stimuli, such as pain. Conversely, positive punishment adds negative reinforcers, and negative punishment removes positive reinforcers [375]. | Reinforcement theory leads to examining whether learning can be manipulated by praise mechanisms [262], such as rewards [270], [424] or climbing the leaderboard [876] – while punishments are usually left out. |
| Transtheoretical Model of Behavior Change (TTM) | TTM aims to describe the phases in which changes in human behavior occur. In the precontemplation stage, the individual is not yet aware of the situation and gets in contact with a behavior change through consciousness raising, dramatic belief and environmental reevaluation. In the contemplation stage, self-reevaluation processes asses one's own positioning towards the problem, followed by the preparation stage, where self-liberation leads to the commitment to action. In the action and maintenance stage, continuous reinforcement management, helping relationships, counterconditioning and stimulus control support the actual change in behavior [485]. The decisional balance towards change in behavior depends on two decisive factors: one's own self-efficacy, as described by Bandura [352], and temptation, which describes the intensity of the urge to engage in a certain behavior under difficult situational circumstances [114]. | Scholars aim at designing interventions based on the TTM stages to promote health behavior change [432], [433] as well as changes towards sustainable behavior [56], [434]. |
| Activity theory | In 1978, Vygotsky postulated that human behavior is not a form of a direct relation between stimulus and response, as assumed in reinforcement theory [375], but that rather a complex psychological act takes place, thereby defining the basic triangle of the human activity system [338]. Later, Leontyev suggested that individual actions are inevitably linked to collective activities [877]. This aspect, among others, was added by Engeström to the activity triad to form a structure of human activity [493]. The system consists of a subject (the individual itself) acting towards an object (or goal), mediated by tools and signs and influenced by an activity system of rules and culture, the community (other individuals) and the division of labor in that community [493]. Furthermore, different systems interact in an activity system network [493]. | Research uses the activity triangle to design and evaluate serious games, with the game as the mediating instrument in the activity system (e. g. [435]–[439]). |

Table B.4: Detailed explanation of theoretical foundations, their origins, and their use in research on gamification and serious games.

| Theoretical foundation | Origin and core statements | Use in research on gamification |
|---|---|---|
| Theoretical foundations related to learning | | |
| Social learning theory | Although agreeing with the behaviorist mechanisms such as operant conditioning [375], social learning theory questions the sole significance of reinforcement processes for learning and adds that people often learn from their environment by processes of observational learning [440]. Through observation, individuals model activities and outcomes they witness from others, which causes learning by its informative function – so behavior can be learned before it is performed [440]. There are four interrelated moderating processes that influence behavioral modeling: attention, retention (imaginable and verbal), reproduction and motivation or reinforcement [440]. | The application of social learning theory guides the design of gamified interventions, e. g. by introducing mechanisms that enable social observation processes [442] and by designing role model game characters [443]. |
| Social cognitive theory | Drawing on social learning theory [440], social cognitive theory focuses on the interaction between social and cognitive factors as determinants of behavior [878]. Human functioning is explained as a form of reciprocal determinism: cognitive, biological, and emotional factors, behavior patterns, and environmental events represent interacting determinants of behavior [329]. The second principal assumption of social cognitive theory is that people are not only reactors but agents in a network of sociocultural influences. Through intentionality, forethought, self-regulation and self-reflectiveness (which refers to the theory of self-efficacy, see Bandura, 1982 [352]), sociocultural factors are embedded in psychological processes [329]. Thirdly, cognitive capabilities play an essential role in this self-system: humans are able to cognitively symbolize events and their outcomes before they happen, they learn vicariously through observation and they self-regulate by goal setting [358] and anticipating the consequences of prospective actions [329]. | Usage in gamification research focuses on game-based learning processes and guides the implementation of mechanisms for vicarious learning and the building of self-efficacy [444]–[446] as well as the evaluation of the intervention based on outcome expectations [454]. |
| Constructivist learning theory | Constructivism has a long history in education and philosophy [879], and can be roughly divided in two streams: the individual cognitive constructivism, derived from Piaget (1977) [449], and the sociocultural constructivism, based on the sociocultural ideas of cognitive development by Vygotsky (1978) [338]. Constructivist learning theories, however, share some essential commonalities: they regard learning as an active process of constructing rather than acquiring knowledge, and instruction as a process of supporting that construction rather than communicating knowledge [879]. Jonassen postulates three instructional activities to support learning: modeling – through demonstration and articulation of the reasoning –, coaching – through motivational prompts, help and reflection –and scaffolding – through adjusting and restructuring of tasks [339]. | Game-based learning includes constructivist principles, such as experiential learning and participation [270], and researchers aim at designing gamification in such way that self-reflection is encouraged (e. g. [450], [451]). |

Table B.4: Detailed explanation of theoretical foundations, their origins, and their use in research on gamification and serious games.

| Theoretical foundation | Origin and core statements | Use in research on gamification |
|---|---|---|
| Sociocultural theory of cognitive development | The sociocultural theory of cognitive development represents a theory of sociocultural constructivism. In the same work in which Vygotsky articulated the human activity system triangle [338], he emphasized the role of social interaction on two levels: first, on the social dimension (interpsychological) and second, on the psychological dimension (intrapersonal) [338]. Tools such as language, art or writing assist the development of cognitive functions to move from the social dimension to the psychological plane [880], so that external functions are internalized to become inner functions [338]. A particular concept of the sociocultural theory is the Zone of Proximal Development, i.e., the distance between the actual level of development and the level of potential development that can be acquired through guidance, peer cooperation, or instruction [338]. Instruction and instructional tools should therefore aim at creating new, higher levels of development rather than to train existing skills [881]. | Interventions based on sociocultural theory are designed to scaffold the learner within his or her zone of proximal development by being adaptive and personalized to foster the learner's development (e.g. [447], [448]) |
| Cognitive load theory | Sweller hypothesized that learning and problem solving occasionally contradict each other due to two related mechanisms: selective attention and cognitive processing capability, or cognitive load. Since conventional problem solving by means-end analysis may require a high level of cognitive effort, it may not simultaneously contribute to schema acquisition [116]. While intrinsic cognitive load results from the interactivity and complexity of the learning material itself, extraneous cognitive load arises from the instructional process. To reduce this extraneous cognitive load, five basic principles of human cognition must be considered [489]: the information store principle, the borrowing and reorganizing principle, the randomness as genesis principle, the narrow limits of change principle and the environment organizing and linking principle. The reduction of extraneous load allows an increase in working memory resources devoted to intrinsic cognitive load and enhances learning. | The central discussion about applying cognitive load theory in game-based learning concerns whether games can be designed in such a way that they reduce extraneous cognitive load or if they increase cognitive load and thus prevent participants from learning (e. g. [15], [461], [462]). |

Table B.4: Detailed explanation of theoretical foundations, their origins, and their use in research on gamification and serious games.

| Theoretical foundation | Origin and core statements | Use in research on gamification |
|---|---|---|
| Situated learning theory | Situated learning theory suggests that learning is usually unintentional and embedded in activities, contexts and culture [370], [371]. Thus, conceptual knowledge cannot be abstracted from the situations in which it is learned and used [370]. Hence, learning environments need to be designed in such an authentic way that students can learn by linking their prior knowledge to real-world scenarios as they participate in the learning activities [453]. There are several related pedagogical models rooted in this idea of situated cognition, for example cognitive apprenticeship, problem-based learning, learning-by-design and case-based learning, among others. They all share common principles of embedding learning in complex, realistic, and relevant contexts, integrating social negotiation as an integral part of learning, supporting multiple perspectives and multiple modes of representation, encouraging ownership in learning and promoting self-awareness of the knowledge construction process [502]. | Educational games and game-based learning environments are considered as effective situated learning environments in which students can acquire problem-solving abilities through playing the game [453], [882]. Thus, situated learning theory and its principles are applied to guide the design of game-based learning as situated problem-solving context (e.g. [454]–[456]). |
| Experiential learning theory | The theory of experiential learning builds on several other theories of learning, e.g. constructivist learning and social constructivism [501], and emphasizes the meaning-making process of the individual's direct experience in the absence of a teacher [410]. The core assumption of experiential learning theory is that knowledge is acquired through personal and environmental experiences rather than instruction [452]. The learning process is portrayed as an idealized learning cycle where the student iteratively learns through a sequence of concrete experience, reflective observation, abstract conceptualization and active experimentation [501]. Furthermore, these four steps in the learning cycle can be diverted into nine different learning styles that each involve one or multiple sequences: Initiating, Experiencing, Imagining, Reflecting, Analyzing, Thinking, Deciding, Acting and Balancing [501]. | Experiential learning theory is often used in research on game-based learning to guide the design of educational games (e.g. [457]–[459]) , but it has also been applied to evaluate the learning outcomes of game-based learning ([504], [883]). |
| Multimedia learning theory | Multimedia learning theory, also referred to as cognitive theory of multimedia learning, draws on dual coding theory [884], Baddeley's working memory theory [885], Wittrock's generative theory [886] and cognitive load theory [116] and states that a learner possesses a visual information processing system and a verbal information processing system [460]. Beside this dual channel principle, multimedia learning theory suggests that learners have a limited capacity for processing in each channel and that learning occurs through active processing, which means that learners attend to relevant information, mentally organize it to form a coherent representation (essential processing) and relate it to prior knowledge (generative processing) [503]. | Multimedia learning theory guides game-based learning design in such way that extraneous processing, thus cognitive processing that distracts from active processing of the learning content, is aimed to be reduced through choosing suitable game features [463], [464], [503]. |

C

# Design Principles

## C.1 List of Excluded Full-Texts

Table C.1: List of excluded full texts during the review on design principles for gamification and persuasive systems.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Conference | Lamprinou & Paraskeva, 2015 [887] | Gamification design framework based on SDT for student motivation | International Conference on Interactive Mobile Communication Technologies and Learning (IMCL) | CA: Missing description of research method to obtain principles |
| Conference | Gunta et al., 2018 [888] | Gamification Paradigm for WebApps Design Framework | 2018 International Conference on Computer, Communication, and Signal Processing (ICCCSP) | CA: Missing research goal, missing description of research method |
| Journal | McDaniel & Fanfarelli, 2016 [889] | Building Better Digital Badges: Pairing Completion Logic With Psychological Factors | Simulation {&} Gaming | Design process, not principles |
| Conference | Cabezas, 2015 [890] | On combining gamification theory and ABET criteria for teaching and learning engineering | 2015 IEEE Frontiers in Education Conference (FIE) | Design process, not principles |
| Journal | Deterding, 2015 [511] | The lens of intrinsic skill atoms: A method for gameful design | Human-Computer Interaction | Design process, not principles |
| Conference | Jalowski et al., 2019 [891] | Facilitating collaborative design: A toolkit for integrating persuasive technologies in design activities | Procedia CIRP | Design process, not principles |
| Journal | Liu et al., 2018 [892] | Gamification's impact on manufacturing: Enhancing job motivation, satisfaction and operational performance with smartphone-based gamified job design | Human Factors and Ergonomics In Manufacturing | Design process, not principles |

Table C.1: List of excluded full texts during the review on design principles for gamification and persuasive systems.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Conference | Metwally et al., 2020 [893] | Micro Design Approach for Gamifying Students' Assignments | 2020 IEEE 20th International Conference on Advanced Learning Technologies (ICALT) | Design process, not principles |
| Conference | Mubin et al., 2019 [894] | A Review on Gamification Design Framework: How They Incorporated for Autism Children | 2019 4th International Conference and Workshops on Recent Advances and Innovations in Engineering (ICRAIE) | Design process, not principles |
| Journal | Alomar et al., 2016 [895] | The design of a hybrid cultural model for Arabic gamified systems | Computers in Human Behavior | Design/game elements, not principles |
| Journal | Buckley et al., 2018 [896] | A Gamification–Motivation Design Framework for Educational Software Developers | Journal of Educational Technology Systems | Design/game elements, not principles |
| Conference | Kim et al., 2015 [897] | Towards Designing a Mobile Social Learning Application with Meaningful Gamification Strategies | 2015 IEEE 15th International Conference on Advanced Learning Technologies | Design/game elements, not principles |
| Journal | Kotsopoulos et al., 2018 [538] | Employee Profiles and Preferences towards IoT-enabled Gamification for Energy Conservation | International Journal of Serious Games | Design/game elements, not principles |
| Conference | Shih et al., 2017 [898] | Selecting persuasive strategies for design for energy-saving behavior | 2017 International Conference on Applied System Innovation (ICASI) | Design/game elements, not principles |
| Journal | Shih & Jheng, 2017 [899] | Selecting Persuasive Strategies and Game Design Elements for Encouraging Energy Saving Behavior | Sustainability | Design/game elements, not principles |
| Conference | Haaranen et al., 2017[900] | Software Architectures for Implementing Achievement Badges - Practical Experiences | 2014 International Conference on Teaching and Learning in Computing and Engineering | Functional requirements, not principles |

Table C.1: List of excluded full texts during the review on design principles for gamification and persuasive systems.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Abdullahi et al., 2019 [901] | Gender, Age and Subjective Well-Being: Towards Personalized Persuasive Health Interventions | Information | No design principles developed |
| Journal | Asbjørnsen, 2019 [902] | Persuasive system design principles and behavior change techniques to stimulate motivation and adherence in electronic health interventions to support weight loss maintenance: Scoping review | Journal of Medical Internet Research | No design principles developed |
| Conference | Azout & Lefdaoui, 2018 [903] | Gamification design frameworks: a systematic mapping study | 2018 6th International Conference on Multimedia Computing and Systems (ICMCS) | No design principles developed |
| Conference | Bucchiarone et al., 2019 [904] | GDF: A Gamification Design Framework Powered by Model-Driven Engineering | 2019 ACM/IEEE 22nd International Conference on Model Driven Engineering Languages and Systems Companion (MODELS-C) | No design principles developed |
| Journal | Corbett, 2013 [190] | Designing and Using Carbon Management Systems to Promote Ecologically Responsible Behaviors. | Journal of the Association for Information Systems | No design principles developed |
| Journal | Dincelli et al., 2020 [905] | Choose your own training adventure: designing a gamified SETA artefact for improving information security and privacy through interactive storytelling | European Journal of Information Systems | No design principles developed |
| Journal | Dithmer et al., 2016 [906] | 'The Heart Game': Using gamification as part of a telerehabilitation program for heart patients | Games for Health | No design principles developed |
| Conference | Faisal et al., 2019 [907] | Persuasive system design for global acceptance of smartphone apps | Procedia Computer Science | No design principles developed |
| Journal | Halttu & Oinas-Kukkonen, 2017 [908] | Persuading to Reflect: Role of Reflection and Insight in Persuasive Systems Design for Physical Health. | Human-Computer Interaction | No design principles developed |

Table C.1: List of excluded full texts during the review on design principles for gamification and persuasive systems.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Hammedi et al., 2017 [909] | The use of gamification mechanics to increase employee and user engagement in participative healthcare services. | Journal of Service Management | No design principles developed |
| Journal | Haworth et al., 2020 [910] | Gamification of Crowd-Driven Environment Design | IEEE Computer Graphics and Applications | No design principles developed |
| Conference | Kamunya et al., 2019 [911] | A Gamification Model For E-Learning Platforms | 2019 IST-Africa Week Conference (IST-Africa) | No design principles developed |
| Journal | Kungwenge & Evans, 2020 [912] | Sana: A Gamified Rehabilitation Management System for Anterior Cruciate Ligament Reconstruction Recovery | APPLIED SCIENCES-BASEL | No design principles developed |
| Conference | Kurniawan & Widyani, 2017 [913] | Sci-leam: A novel E-leaming platform based on gamification and social media approach | 2017 6th International Conference on Electrical Engineering and Informatics (ICEEI) | No design principles developed |
| Journal | Lee et al., 2018 [914] | Deriving a Gamified Learning-Design Framework Towards Sustainable Community Engagement and Mashable Innovations in Smart Cities: Preliminary Findings | International Journal of Knowledge and Systems Science | No design principles developed |
| Journal | Marell-Olsson, 2019 [915] | University Students as Co-creators in Designing Gamification Teaching Activities using Emergent Technologies in Swedish K-12 Education | Interaction Design and Architecture(s) | No design principles developed |
| Journal | Matthews et al., 2016 [916] | Persuasive Technology in Mobile Applications Promoting Physical Activity: a Systematic Review | Journal of Medical Systems | No design principles developed |
| Journal | Mintz & Aagaard, 2012 [917] | The application of persuasive technology to educational settings | Educational Technology Research and Development | No design principles developed |
| Journal | Mogles et al., 2018 [918] | A computational model for designing energy behaviour change interventions | User Modeling and User-Adapted Interaction | No design principles developed |

Table C.1: List of excluded full texts during the review on design principles for gamification and persuasive systems.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Mohadis et al., 2016 [919] | Designing a persuasive physical activity application for older workers: understanding end-user perceptions. | Behaviour {&} Information Technology | No design principles developed |
| Journal | O'Connor & Cardona, 2019 [920] | Gamification: A Pilot Study in a Community College Setting | Journal of Education | No design principles developed |
| Journal | Oyibo & Vassileva, 2019 [921] | Investigation of the Moderating Effect of Culture on Users' Susceptibility to Persuasive Features in Fitness Applications | Information | No design principles developed |
| Journal | Park & Kim, 2019 [922] | A Badge Design Framework for a Gamified Learning Environment: Cases Analysis and Literature Review for Badge Design | JMIR SERIOUS GAMES | No design principles developed |
| Conference | Pernencar et al., 2018 [923] | Planning a health promotion program: Mobile app gamification as a tool to engage adolescents | Procedia Computer Science | No design principles developed |
| Journal | Robson et al., 2015 [924] | Is it all a game? Understanding the principles of gamification | Business Horizons | No design principles developed |
| Journal | Rodrigues et al., 2016 [925] | Gamification: A framework for designing software in e-banking | Computers in Human Behavior | No design principles developed |
| Journal | Salvi et al., 2018 [926] | An m-Health system for education and motivation in cardiac rehabilitation: The experience of HeartCycle guided exercise | Journal of Telemedicine and Telecare | No design principles developed |
| Conference | Thach & Phan, 2019 [927] | Persuasive Design Principles in Mental Health Apps: A Qualitative Analysis of User Reviews | 2019 IEEE-RIVF International Conference on Computing and Communication Technologies (RIVF) | No design principles developed |
| Journal | Tinati et al., 2017 [928] | An investigation of player motivations in Eyewire, a gamified citizen science project | Computers in Human Behavior | No design principles developed |
| Conference | Yusoff et al., 2011 [929] | Virtual Hajj (V-Hajj) — Adaptation of persuasive design in virtual environment (VE) and multimedia integrated approach learning courseware methodology | 2011 IEEE Conference on Open Systems | No design principles developed |

Table C.1: List of excluded full texts during the review on design principles for gamification and persuasive systems.

| Type | Authors | Title | Journal | Annotation |
|---|---|---|---|---|
| Journal | Botha-Ravyse et al., 2018 [930] | Lessons Learned from Gamification of a Learning Experience: A Case Study | South African Journal for Research in Sport Physical Education and Recreation | No design principles developed |
| Conference | Shih & Hsing, 2012 [931] | Persuasive design for LOHAS products with physical activity | 2012 Electronics Goes Green 2012+ | No design principles developed |
| Journal | van Agteren et al., 2018 [932] | Kickit: The development of an evidence-based smoking cessation smartphone app | Translational Behavioral Medicine | No design principles developed |
| Conference | Àlvarez-Cedillo, 2018 [933] | Description of a Gamification Design Framework | 2018 IEEE Biennial Congress of Argentina (ARGENCON) | Not english |
| Conference | Alami & Dalpiaz, 2017 [934] | A Gamified Tutorial for Learning About Security Requirements Engineering | 2017 IEEE 25th International Requirements Engineering Conference (RE) | Secondary study |
| Journal | Orji & Mandryk, 2014 [935] | Developing culturally relevant design guidelines for encouraging healthy eating behavior | International Journal of Human-Computer Studies | No design principles developed |
| Conference | Pirker et al., 2015 [936] | Enhancing online and mobile experimentations using gamification strategies | 2015 3rd Experiment International Conference (exp.at'15) | Design process, not principles |

# D Focus Group Interviews

## D.1 Coding Guideline for the Focus Group Interviews

Table D.1: Coding guideline for the categories derived from DOI theory [214] and activity theory [290].

| Category | Definition for coding | Anchor example |
|---|---|---|
| Categories derived from activity theory | | |
| Subject | Challenges related to employees as individuals in terms of their perceptions, attitudes, and behaviors | ”I’m not, let’s say app person or I don’t have Instagram or whatever where I need to share what I’m doing all the time.” (P2) |
| Instrument | Challenges related to the design, structure, or functionality of the green IS | ”I personally found the description text a bit long, which was most likely because it was just mostly a blog text. I think you could reduce that visually, you can make bullet points or something, then it reads faster and easier. I found that, that’s why I’m very quickly tired to even read these texts sometimes.” (P15) |
| Object | Challenges related to the topic of sustainability and sustainable behavior in the context of the work environment | ”Of course, it’s also like that, you don’t have a real need for it. So I have an app, no idea for shopping, where I can organize the shopping list cool. I always use it when I have the need to go shopping. But here...” (P4) |
| Community | Challenges related to social dynamics between colleagues | ”If the department head doesn’t model that, it won’t work with the rest.” (P12) |
| Rules | Challenges in terms of guidelines for action between colleagues both in the green IS and in the organizational environment | ”Sounds nice, but I have so many things to do. What, what it’s important for, for you, I can say to my manager. The manager will say, okay, then you have to do your work, not to use the app for example.” (P1) |
| Division of labor | Challenges related to task specialization among colleagues | - no anchor example found - |
| Categories derived from DOI theory | | |
| Knowledge | Challenges related to awareness of the green IS, understanding of its use, and knowledge of its operating principles | ”So that you come into the app and don’t directly understand what you’re supposed to do there.” (P17) |
| Persuasion | Challenges related to attitude formation for the use of the green IS | ”I think nobody would look ahead because of this app and say that you are now eating a vegetarian lunch. Of course, it’s a matter of attitude, because once you’ve washed the apple in the bowl, it’s certainly in your head at some point and you do it automatically. But it is not necessarily an indication for the future.” (P12) |

Table D.1: Coding guideline for the categories derived from DOI theory [214] and activity theory [290].

| Category | Definition for coding | Anchor example |
|---|---|---|
| Decision | Challenges associated with starting to use the green IS after building positive attitudes, which may account for a gap between attitudes and behaviors | "But then you just don't do it somehow and think to yourself, yeah, come on, the moment is bad or something and then it's already forgotten right away when you've arrived at the thought that you'll do it later or something." (P8) |
| Implementation | Challenges related to the use of the green IS | "Gamification didn't resonate with me at all. I felt zero challenge." (P18) |
| Confirmation | Challenges associated with reevaluating the use of green IS in terms of dissatisfaction with its performance, unmet expectations, potential dissonance, and other reasons for disengagement | "And the question I ask myself is for the employee afterwards, at the end of the day, what's the long-term motivation? I can imagine that this has the gamification effect that it's supposed to have. Quite blatantly at the beginning team KPs against who knows what. That's all great, but it wears off after (...) I guess 1 to 2 weeks this effect is gone, it's gone." (P7) |

# E

# Field Experiment

## E.1 Items Used in the Two-Monthly Survey

Table E.1: Full list of survey items used in the two-monthly quantitative survey during the field experiment.

| Construct | Name | $\beta$ | Item | Scaling | Source |
|---|---|---|---|---|---|
| **Pro-environmental attitude** | | | | | |
| Instrumental attitude | | | | | |
| *[This] aspect appears to reflect the behavior's perceived instrumentality (i.e., its anticipated positive or negative consequences) [604, p. 84]* | I-A1 | 0.665 | For me, behaving in environmentally-friendly ways is... | Semantic differential 1 (bad) - 7 (good) | [154], [171] after [604] |
| | I-A2 | 0.500 | For me, behaving in environmentally-friendly ways is... | Semantic differential 1 (foolish) - 7 (wise) | [154], [171] after [604] |
| | I-A3 | 0.747 | For me, behaving in environmentally-friendly ways is... | Semantic differential 1 (harmful) - 7 (beneficial) | [171] after [604] |
| Experiential attitude | | | | | |
| *[This aspect] appears to reflect the positive or negative experiences perceived to be associated with performing the behavior [604, p. 84]* | E-A1 | 0.791 | For me, behaving in environmentally-friendly ways is... | Semantic differential 1 (unpleasant) - 7 (pleasant) | [154], [171] after [604] |
| | E-A2 | 0.785 | For me, behaving in environmentally-friendly ways is... | Semantic differential 1 (unenjoyable) - 7 (enjoyable) | [154] after [604] |
| | E-A3 | 0.625 | For me, behaving in environmentally-friendly ways is... | Semantic differential 1 (boring) - 7 (interesting) | [604] |
| **Subjective norm** | | | | | |
| Injunctive norm | | | | | |
| *Injunctive norms refer to perceptions concerning what should or ought to be done with respect to performing a given behavior [604, p. 131]* | I-SN1 | 0.638 | Most of my colleagues think I should behave in environmentally-friendly ways. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [154], [171] after [604] |
| | I-SN2 | 0.929 | Most of my colleagues would want me to behave in environmentally-friendly ways. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [154], [171] after [604] |

Table E.1: Full list of survey items used in the two-monthly quantitative survey during the field experiment.

| Construct | Name | $\beta$ | Item | Scaling | Source |
|---|---|---|---|---|---|
| | I-SN3 | 0.973 | Most of my colleagues would prefer that I behave in environmentally-friendly ways. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [154], [171] after [604] |
| Descriptive norm<br>*Descriptive norms refer to perceptions that others are or are not performing the behavior in question [604, p. 131]* | D-SN1 | 0.577 | Most of my colleagues behave in environmentally-friendly ways. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [604], [609] |
| | D-SN2 | 0.503 | Most of my colleagues engage in the protection of the environment. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [604], [609] |
| | D-SN3 | 0.599 | How many of your colleagues behave in environmentally-friendly ways? | Likert 1 (virtually none) - 7 (almost all) | adapted from [604] |
| **Perceived behavioral control (equals self-efficacy [604, p. 166], [426, p. 668])** | | | | | |
| Capacity<br>*Items on [capacity] refer primarily to the ability to perform a behavior, that is, to the belief that one [...] is able to [...] performing the behavior. [604, p. 165-166]* | C-PBC1 | 0.793 | I am confident that if I want, I can behave in environmentally-friendly ways. | Likert 1 (extremely disagree) - 7 (extremely agree) | [154], [171] after [604] |
| | C-PBC2 | 0.748 | I am fully capable of behaving in environmentally-friendly ways. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [604], [609] |
| | C-PBC3 | 0.435 | I find it easy to behave in environmentally-friendly ways. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [604], [609] |
| Autonomy<br>*Items on [autonomy] deal mainly with degree of control over performing the behavior. Also included on this factor are judgments that performance of the behavior is "up to me." [604, p. 166]* | A-PBC1 | 0.783 | Whether or not I behave in environmentally-friendly ways is completely up to me. | Likert 1 (extremely disagree) - 7 (extremely agree) | [154], [171], [173] after [604] |
| | A-PBC2 | 0.817 | I am in full control of behaving in environmentally-friendly ways. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [604], [609] |

Table E.1: Full list of survey items used in the two-monthly quantitative survey during the field experiment.

| Construct | Name | $\beta$ | Item | Scaling | Source |
|---|---|---|---|---|---|
| | A-PBC3 | 0.689 | Behaving environmentally-friendly is out of my hands. (R) | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [604], [609] |
| **Hedonic enjoyment** | | | | | |
| *Engage in an activity for the sole pleasure and satisfaction derived from its practice [605, p. 441]* | HE-1 | 0.959 | Behaving in environmentally-friendly ways gives me my strongest sense of enjoyment. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [610] |
| | HE-2 | 0.890 | Behaving in environmentally-friendly ways gives me my greatest pleasure. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [610] |
| | HE-3 | 0.682 | When I behave in environmentally-friendly ways I feel good. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [610] |
| **Perceived environmental knowledge** | | | | | |
| *An individual's perceived environmental knowledge (awareness of environmental issues and consequences of human actions on environment) [606, p. 6]* | PEK-1 | 0.814 | I know how to behave in environmentally-friendly ways. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [606] |
| | PEK-2 | 0.741 | I know how I could lower the ecological harm with my behavior. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [606] |
| | PEK-3 | 0.770 | I understand how I could reduce the negative environmental consequences of my behavior. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [606] |
| | PEK-4 | 0.604 | I understand how to protect the environment in the long-term. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [606] |
| **Behavioral intention** | | | | | |
| *Readiness to engage in a behavior, a construct that incorporates such concepts as willingness, behavioral expectation, and trying [604, p. 43]* | BI-1 | 0.714 | I am willing to behave in environmentally-friendly ways in the future. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [171], [937] after [604] |

Table E.1: Full list of survey items used in the two-monthly quantitative survey during the field experiment.

| Construct | Name | $\beta$ | Item | Scaling | Source |
|---|---|---|---|---|---|
| | BI-2 | 0.906 | I plan to behave in environmentally-friendly ways in the future. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [171], [609], [937] after [604] |
| | BI-3 | 0.760 | I will expend effort to behave in environmentally-friendly ways in the future. | Likert 1 (extremely disagree) - 7 (extremely agree) | adapted from [171] after [604] |
| **Pro-environmental behavior (PEB)** | | | | | |
| Task-related PEB | | | | | |
| *The extent to which employees complete their required work tasks in environmentally friendly ways [153, p. 157]* | TR-PEB1 | 0.836 | Today, I adequately completed assigned duties in environmentally-friendly ways. | Likert 1 (never) - 5 (always) | [153] |
| | TR-PEB2 | 0.784 | Today, I fulfilled responsibilities specified in my job description in environmentally-friendly ways. | Likert 1 (never) - 5 (always) | [153] |
| | TR-PEB3 | 0.887 | Today, I performed tasks that are expected of me in environmentally-friendly ways. | Likert 1 (never) - 5 (always) | [153] |
| Proactive PEB | | | | | |
| *The extent to which employees take initiative to engage in environmentally friendly behaviors that move beyond the realm of their required work tasks [153, p. 158]* | P-PEB1 | 0.350 | Today, I took a chance to get actively involved in environmental protection at work. | Likert 1 (never) - 5 (always) | [153] |
| | P-PEB2 | 0.493 | Today, I took initiative to act in environmentally-friendly ways at work. | Likert 1 (never) - 5 (always) | [153] |
| | P-PEB3 | 0.491 | Today, I did more for the environment at work than I was expected to. | Likert 1 (never) - 5 (always) | [153] |

# Curriculum Vitae:
# Jeanine Kirchner-Krath (b. Krath)

## Academic Experience

| | |
|---|---|
| 01/2020 - 05/2023 | **Ph.D. Information Management**<br>(supported by a scholarship of the German Economic Foundation)<br>University of Koblenz, Koblenz, Germany |
| 10/2016 - 09/2019 | **Master of Science Information Management**<br>University of Koblenz-Landau, Koblenz, Germany |
| 06/2017 - 08/2017 | **Summer Sessions**<br>University of California Los Angeles (UCLA), Los Angeles, USA |
| 04/2013 - 09/2016 | **Dual-Subject Bachelor Psychology and Management**<br>University of Koblenz-Landau, Koblenz, Germany |

## Professional Experience

| | |
|---|---|
| 01/2020 - 05/2023 | **Academic Director of the GAMOS Competence Center for Gamification in Organizations and for Sustainability and Scientific Assistant**<br>Central Institute for Scientific Entrepreneurship and International Transfer, University of Koblenz, Koblenz, Germany |
| 09/2022 - 12/2022 | **Visiting Researcher**<br>Gamification Group, Tampere University, Tampere, Finland |
| 05/2018 - 05/2020 | **Marketing and Customer Success Manager**<br>Particulate Solutions GmbH, Koblenz, Germany |

# List of Publications

## Peer-reviewed Journal Articles

**J. Krath**, B. Morschheuser, N. Xi, H. F. O. von Korflesch, and J. Hamari, "Challenges in the adoption of sustainability information systems: a study on green IS in organizations", Int. J. Inf. Manag., under review.

B. Kordyaka, S. Park, **J. Krath**, and S. Laato, "Exploring the relationship between offline cultural environments and toxic behavior tendencies in multiplayer online games", ACM Trans. Soc. Comput., vol. Just Accep, Feb. 2023, `https://doi.org/10.1145/3580346`.

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**J. Krath**, L. Schürmann, and H. F. O. von Korflesch, "Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning", Comput. Human Behav., vol. 125, p. 106963, Dec. 2021, `https://doi.org/10.1016/j.chb.2021.106963`. (*Top 10 most downloaded articles of CHB since April 2022*)

## Peer-reviewed Conference Papers

**J. Krath**, A. C. T. Klock, B. Morschheuser, S. Park, N.-Z. Legaki, H. F. O. von Korflesch, and J. Hamari, "Designing tailored gamification: A mixed-methods study on expert perspectives and user behavior in a gamified app for sustainability at work", in 7th International GamiFIN Conference, Levi, Finland, accepted for publication. *(best presentation award)*

**J. Krath**, B. Morschheuser, H. F. O. von Korflesch, and J. Hamari, "How to increase sustainable engagement in the workplace through green IS: the role of instructional and motivational design features", in Thirty-first European Conference on Information Systems (ECIS 2023), Kristiansand, Norway, Jun. 2023, p. 244, `https://aisel.aisnet.org/ecis2023_rp/244/`.

**J. Krath**, M. Altmeyer, G. F. Tondello, and L. E. Nacke, "Hexad-12: Developing and Validating a Short Version of the Gamification User Types Hexad Scale", in Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI'23), Hamburg, Germany, Apr. 2023, `https://doi.org/10.1145/3544548.3580968`.

B. Kordyaka, **J. Krath**, S. Laato, S. Park, and K. Jahn, "Exploring the Dark Side of Multiplayer Online Games: The Relationship between contact experiences and sexism", in AMCIS 2022 Proceedings, Aug. 2022, p. 3, `https://aisel.aisnet.org/amcis2022/vcc/vcc/3`. *(Best AMCIS 2022 top 25% complete papers)*

C. Tuschner, **J. Krath**, J. Bings, M. Schwenkmezger, M. Etzkorn, and H. von Korflesch, "Leading in the Digital Age: A Systematic Review on Leader Traits in the Context of e-Leadership", in Thirtieth European Conference on Information Systems (ECIS 2022), [Online], Jun. 2022, p. 63, `https://aisel.aisnet.org/ecis2022_rp/63/`. *(nominated for best paper award)*

A. Palmquist, O. Goethe, **J. Krath**, J. Rosenlund, and M. Helmefalk, "Design Implications for a Gamified Recycling House", in HCI in Games. HCII 2022. Lecture Notes in Computer Science, vol 13334., X. Fang, Ed. Springer Cham, 2022, pp. 289–305, `https://doi.org/10.1007/978-3-031-05637-6_18`. *(invited paper)*

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**J. Krath**, B. Morschheuser, and H. F. O. von Korflesch, "Designing Gamification for Sustainable Employee Behavior: Insights on Employee Motivations, Design Features and Gamification Elements", in 55th Hawaii International Conference on System Sciences (HICSS), [Online], Jan. 2022, pp. 1594–1603, `http://hdl.handle.net/10125/79530`.

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**J. Krath**, S. Silva, and H. F. O. von Korflesch, "Gamification for sustainable employee behavior: a systematic review informed by goal-setting theory", presented at the 21st Annual Conference of the European Academy of Management (EURAM), [Online], Jun. 2021.

**J. Krath** and H. F. O. von Korflesch, "Designing gamification and persuasive systems: a systematic literature review", in 5th International GamiFIN Conference, [Online], Apr. 2021, pp. 100–109, `https://ceur-ws.org/Vol-2883`. *(best presentation award)*

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**J. Krath**, "Gamification for Sustainable Employee Behavior", in Extended Abstracts of the 2021 Annual Symposium on Computer-Human Interaction in Play, [Online], Oct. 2021, pp. 411–414, `https://doi.org/10.1145/3450337.3483523`.

### Book Chapters

L. Schürmann, **J. Krath**, and H. F. O. von Korflesch, "Gamification - motivierendes Lehren und Lernen spielend leicht gemacht", in Praxishandbuch schulische Digitalisierung, Band 1, M. Ernst-Heidenreich, C. Quaiser-Pohl, F. Sorajewski, A. Werger, Ed. Beltz Juventa (under review).

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With the increasing importance and urgency of climate change, companies are challenged to contribute to sustainable development. However, existing corporate contributions have been criticized as insufficient, which could be particularly caused by a lack of employee engagement. In this context, gamification has been proposed as a promising, innovative tool to motivate sustainable employee behaviors in the workplace.

This dissertation conceptualizes, designs, and evaluates a holistic gamified intervention that supports employees in various sustainable behaviors in their daily activities.

The research findings provide the following theoretical contributions to the research fields of gamification, green IS and sustainable employee behavior:

- Understanding of the psychological mechanisms of gamification and gameful design
- Understanding of the contextual challenges of implementing green IS in an organizational context, arising from employee motivations, expectations, and experiences
- Understanding of how gamification and green IS (design) influences sustainable employee behavior in organizations

In addition, the project yields several practical contributions for the design of gamification, green IS and interventions for sustainable employee behavior:

- Design principles for gamification and persuasive systems in general
- Design recommendations for gamification for sustainability and green IS in organizational settings in particular
- Guidance for selecting (gameful) design features to motivate sustainable employee behaviors