Long-term information management in Collaborative Project Management Software

A thesis submitted for the

Bachelor of Science in Information Management

by

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Declaration/Erklärung

I declare that:

This thesis presents work carried out by myself and does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university. To the best of my knowledge, it does not constitute any previous work published or written by another person except where due reference is made in the text.

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Abstract (English)

With global and distributed project teams being increasingly common Collaborative Project Management is becoming the prevalent paradigm for the work in most organisations. Software has for many years been one of the most used tools for supporting Project Management and with the focus on Collaborative Project Management and accompanied by the emergence of Enterprise Collaboration Systems (ECS), Collaborative Project Management Software (CPMS) is gaining increased attention.

This thesis examines the capabilities of CPMS for the long-term management of information which not only includes the management of files within these systems, but the management of all types of digital business documents, particularly social business documents. Previous research shows that social content in collaboration software is often poorly managed which poses challenges to meeting performance and conformance objectives in a business.

Based on literature research, requirements for the long-term management of information in CPMS are defined and 7 CPMS tools are analysed regarding the content they contain and the functionalities for the long-term management of this content they offer. The study shows that CPMS by and large are not able to meet the long-term information management needs of an organisation on their own and that only the tools geared towards enterprise customers have sufficient capabilities to support the implementation of an Enterprise Information Management strategy.

Abstract (German)

Mit der verstärkten Verbreitung von globalen und verteilten Projektteams wird kollaboratives Projektmanagement zum vorherrschenden Paradigma für die Arbeit in den meisten Firmen. Software ist seit vielen Jahren eines der meistgenutzten Tools zur Unterstützung von Projektmanagement und mit dem Fokus auf kollaborativem Projektmanagement sowie dem Aufkommen von Enterprise Collaboration Systems (ECS) erfährt kollaborative Projektmanagementsoftware (CPMS) steigende Beachtung.

Diese Arbeit untersucht die Fähigkeiten von CPMS für das Langzeitmanagement von Informationen, welches nicht nur das Management von Dateien innerhalb dieser Systeme, sondern auch das Management aller Arten von Digital Business Documents, insbesondere Social Business Documents umfasst. Vorangegangene Forschung zeigt, dass soziale Inhalte in Kollaborationssoftware oft schlecht verwaltet werden, was Herausforderungen für die Erreichung von Konformitäts- und Performanzzielen eines Unternehmens darstellt.

Basierend auf einer Literaturrecherche werden Anforderungen für das Langzeitmanagement von Informationen in CPMS definiert und 7 CPMS Tools in Bezug auf ihre Inhalte und ihre Funktionalitäten für das Langzeitmanagement dieser Inhalte analysiert. Die Untersuchung zeigt, dass CPMS zum Großteil nicht in der Lage sind die Erfordernisse für das Langzeitmanagement von Informationen mit ihren eigenen Funktionalitäten zu erfüllen und dass nur Tools, die auf größere Firmen ausgerichtet sind, ausreichende Möglichkeiten bieten, um die Implementierung einer Enterprise Information Management Strategie zu unterstützen.

Table of Contents

List of Figures ix
List of Tables xi
1 Introduction 1
1.1 Problem Statement and Motivation 1
1.2 Outline of the Thesis 4
2 Research Design 6
2.1 Research Objectives and Questions 6
2.2 Research Methods 7
2.3 Scope and Limitations of the research 8
3 Collaborative Project Management 11
3.1 Project Management and its Software 11
3.2 Enterprise Collaboration and its Software 14
3.3 Collaborative Project Management and its Software 16
4 Long-term Information Management 20
4.1 Enterprise Information Management 20
4.2 Records Management 25
4.3 Knowledge Management 27
4.4 Enterprise Search and e-Discovery 29
5 Summary of long-term information management requirements 32
6 Tool Research 34
6.1 Tool selection 34
6.2 Tool analysis 37
7 Classification and Evaluation of the Status Quo 50
8 Summary and Future Work 54
8.1 Summary of the Findings 54
8.2 Future Work 56
References 57

List of Figures

Figure 2-1: Research steps of this thesis 8

Figure 3-1: Project Management Process Groups and Project Boundaries 11

Figure 3-2: The relationship of Social Software, Social Media and Enterprise Collaboration Systems 15

Figure 3-4: Two interpretations of "Collaborative Project Management" 16

Figure 3-5: Range of Collaborative Project Management Software from classic Project Management Information Systems to Enterprise Collaboration Systems 17

Figure 3-6: A collaborative project management Framework 18

Figure 3-7: Hierarchy of collaboration in relation to requirements for task and process structure and requirements for interactivity of communication 19

Figure 4-1: Categories of enterprise data 21

Figure 4-2: Components of the Enterprise Content Management ecosystem 22

Figure 4-3: The information lifecycle 24

Figure 4-4: Records and the associated metadata are used to apply policies that prompt Records Management processes 26

Figure 4-5: SECI Model 27

Figure 4-6: A generic Lessons Learned Process 28

Figure 4-7: The structure of a federated search engine 30

List of Tables

Table 3-1: PM Process Group and Knowledge Area Mapping 12

Table 4-1: Examples of attached social content 23

Table 5-1: Requirements for long-term information management in CPMS 33

Table 6-1: List of software tools for tool selection 35

Table 6-2: Findings of the tool analysis for Wrike 37

Table 6-3: Findings of the tool analysis for Projectplace 39

Table 6-4: Findings of the tool analysis for iMeet Central 41

Table 6-5: Findings of the tool analysis for active.collab 43

Table 6-6: Findings of the tool analysis for Clarizen 44

Table 6-7: Findings of the tool analysis for Teamwork projects 46

Table 6-8: Findings of the tool analysis for easy projects 48

Table 7-1: Requirements for long-term information management met by CPMS 50

1 Introduction

This chapter gives a short overview of current problems in long-term information management in the context of Collaborative Project Management Software and how these problems motivate for the research of this thesis (section 1.1). Furthermore, this chapter introduces the structure of the overall thesis (section 1.2).

1.1 Problem Statement and Motivation

Project management has become a vital part of the work that is done in most organisations. Sooner or later all organisations are involved with project work in some form or another, since a project can be defined as "a temporary endeavor undertaken to create a unique product, service, or result" (PMI 2013). Especially project based organisations (PBOs) are increasingly common, either as standalone companies, as parts of larger corporations or as collaborating networks of multiple organisations (DeFillippi & Arthur 1998; Hobday 2000; Keegan & Turner 2002; Gann & Salter 2000; Lindkvist 2004; in: Sydow 2004, p.1475).

Global and distributed project teams have become the norm rather than the exception, due to increasing global competition (Rochester 2016). There are a number of reasons supporting this, for example:

- The required knowledge of different markets and the benefits associated with the diversity of a project team are relevant in many different industries (Wheatley & Wilemon 1999).
- The high complexity of today's products and projects, which are often interconnected and require very specific knowledge, increases the importance of bringing together team members from different parts of the world (McDonough & Cedrone 1998).
- Trends like outsourcing and off-shoring further increase the need for globally distributed teams (Binder 2016).

However, global projects inherit a number of problems, which Binder (2016) has categorized under the following dimensions:

- Number of distant locations
- Number of different organisations
- Country cultures
- Different languages
- Time zones

Many of these problems can be improved upon with the use of Information and Communication Technologies (ICT). This thesis will focus on ICT software solutions that enable distributed teams to collaborate on project activities. These types of software especially help to solve the issues of different locations, times and organisations by providing virtual project environments (Romano et al. 2002), which is why since the beginning of the 2000s Project Management Software has been the most widely used tool for Project Management (White & Fortune 2002).

One big aspect of Project Management is the communication and collaboration of project members. Thereby, collaboration activities account for at least a quarter of the time spent in traditional business projects (Helbrough 1995) and for up to 70% of the time spent in software development projects (Gorton et al. 1997). Therefore, next to conventional disciplines like risk- or resource-management the management of project related processes like collaboration has become one of the most important activities in Project Management (Romano et al. 2002). The increasing trends of shorter time-to-market windows and the need to stay ahead of increasing competition while dealing with complex projects in distributed teams, which are described above, have also raised the importance of efficient project collaboration (Azzopardi 2006).

Therefore, in 2002 Romano et al. have proposed a prototype for a Collaborative Project Management Software (CPMS) by defining which collaboration functionalities are required to support Project Management. While in 2002 they discovered, that most of the commercial Project Management Software did only support lower levels of collaboration, a study in 2006 already showed that web-based project collaboration systems were becoming more popular, but were still not widely adopted (Chen et al. 2006). In 2014 a study found, that web-based project collaboration systems are being more widely adopted, but are still missing group support functionalities, to support all levels of project collaboration (Ferreira & Tereso 2014). In the latest Magic Quadrant report for Cloud-Based IT Project and Portfolio Management Services the analysts from Gartner consider Social Networking and Collaboration as one of the most important innovations in the area of Project Management Software (Stang et al. 2016a). Most Collaborative Project Management functionalities can be part of full Enterprise Collaboration Systems (ECS) or of traditional Project Management Information Systems (PMIS), but recently many stand-alone, web-based systems have come on the market, which focus on Project Collaboration and which come close to fully supporting all levels of project collaboration as defined by Romano et al. in 2002 (see section 3.3). This type of software and the challenges that come with it, will be in the focus of this thesis.

One of these challenges is posed by the fact that Collaborative Project Management Software generates social content, for example in the form of comments or likes on items like tasks or

project plans. According to Gartner Research social content is one of the fastest growing categories of enterprise content (Koehler-Kruener et al. 2015). It can contain important business information and therefore requires the same management as other, traditional business documents (Hausmann & Williams 2015). However most companies have not yet implemented strategies to manage these types of data (Hausmann et al. 2014). The following problem areas in regard to missing long-term management of social content have been defined by Hausmann & Williams (2016):

- Compliance issues
- Records management issues
- Loss of information quality
- Knowledge management
- Operational risks (not finding information)
- Exporting (transferability)
- Archiving

These problem areas do not only apply to social content, but must be addressed by Enterprise Information Management strategies in general in order to meet the performance and conformance objectives of an organisation (Williams et al. 2014).

With objectives such as the improvement of business processes, increasing revenue and increasing competitiveness (Chua & Lam 2005), one of the most important performance drivers in the context of Project Management is Knowledge Management. Among the most significant barriers of Knowledge Management is the lack of appropriate system support (Ajmal et al. 2010). Particularly software systems that include collaboration features can be crucial in order to assist employees in capturing knowledge and in connecting to experts for the purpose of knowledge sharing (Ackerman et al. 2013; Hansen et al. 1999).

In addition to the performance objectives the other key drivers of EIM can be found in the area of conformance. Especially in regard to Collaboration Software there is uncertainty around the requirements for retention and preservation and the security and privacy of content (Williams & Hardy 2011). Due to the nature of a project – it's uniqueness and temporary limitation – the integration of project-related content into a company's conventional Records Management processes poses a challenge. This issue becomes even more problematic when the project-related content is stored in a CPMS, separately from other enterprise content.

Since performance and conformance objectives are better met, when companies have implemented an EIM strategy (Hausmann et al. 2014), it is important that the software in use can

support the EIM activities either directly or by functionalities like data export or software interfaces. Therefore, this thesis aims to examine the current long-term information management capabilities of CPMS and to determine which functionalities still have to be implemented to sufficiently support Enterprise Information Management strategies and to avoid the above-mentioned problem areas.

1.2 Outline of the Thesis

This section gives an overview of the content of this thesis. Therefore, it briefly summarises the content of each chapter and how they are connected. There are eight chapters of which most are divided into further sections.

In chapter 1.1 the general topic of this thesis was introduced and the main **arguments for the relevance** of the research were given.

Chapter 2 outlines the **research design** used in this thesis. The research questions are introduced and the aim of the study and the main research methods are outlined. Furthermore, the scope as well as the limitations of the research are presented.

In the chapters 3 and 4 **relevant definitions and models** are presented to provide the theoretical background of this thesis.

Chapter 3 establishes the context of **Collaborative Project Management Software**. Therefor current standards in Project Management are summarised and the general category of Enterprise Collaboration Software is introduced. Based on this, the special type of Collaborative Project Management Software is described.

In chapter 4 the relevant aspects of **long-term information management** are explained. First, the general area of Enterprise Information Management is introduced, after which the three most relevant long-term information management activities – Records Management, Knowledge Management and Enterprise Search – are described in greater detail and with special focus on the context of Project Management.

Based on this, the **requirements** for sufficient long-term information management capabilities of a Collaborative Project Management Software are defined in chapter 5. These serve as the basis for the research in the following chapters.

Chapter 6 describes the process and the findings of the **Tool Research**. Available Software tools are examined based on their functionalities to select the set of tools for further analysis that fit the targeted type of Collaborative Project Management Software. These are then analysed for

the types of content they contain and their functionalities for supporting the long-term management of information.

Based on this analysis, the **status quo** of long-term information management in CPMS is determined in chapter 7 by comparing the tool's capabilities to the previously identified requirements.

Finally, chapter 8 gives a **summary of the findings** by reviewing the research questions and an **outlook on further research** is given.

2 Research Design

In this chapter the research design of this thesis is presented. The first section (2.1) describes the objectives and research questions of the study. Section 2.2 illustrates the steps and methods used to answer the research questions. The last section (2.3) defines the scope of this thesis and describes the limitations of the research that is conducted.

2.1 Research Objectives and Questions

The aim of this study is to examine how well the long-term information management needs and requirements are currently met by Collaborative Project Management Software and which challenges for the implementation of an Enterprise Information Management strategy might exist. In this section the different research objectives and the questions that are answered to reach the aim of this study are described.

1) The first objective is to **define the needs and requirements** for the long-term management of different types of information. Therefor literature research on the general area of Enterprise Information Management and on the specifics of information management in the context of Project Management is conducted. The requirements that are identified serve as the basis for the assessment of the status quo. Based on this objective the following two research questions are phrased:

   RQ1a) What are the requirements and needs for the long-term management of information that generally apply in an enterprise context?

   RQ1b) What are the requirements and needs for the long-term management of information that are particularly relevant in the context of Project Management?

2) The second objective is to **identify the software tools** that can be classified as Collaborative Project Management Software and to **analyse them** in respect to their general capabilities. As stated in chapter 1.1 there is no clear distinction between the many kinds of Collaboration Software and Project Management Software and recently the number of web-based project collaboration tools has increased immensely. Therefore, a subset of tools that are exemplary for Collaborative Project Management Software as defined in chapter 3.3 are selected as the first part of the Tool Research. Secondly, these tools are examined more closely to identify their functionalities. This leads to the following research questions:

   RQ2a) Which software tools are available that support Collaborative Project Management?

RQ2b) What are the different types of content that exist in these tools?

RQ2c) What are the long-term information management functionalities for the different types of content of these tools?

3) The third and final objective is the overall **assessment of the status quo** of long-term information management in CPMS. The requirements that were defined as the first research objective are compared to the capabilities of the tools that were identified as the second research objective. Thus, it can be determined how well the long-term information management needs are currently met by CPMS and which challenges for the implementation of an Enterprise Information Management strategy currently exist.

   RQ3a) How are the long-term information management needs and requirements currently met by CPMS?

   RQ3b) Which capabilities do CPMS currently lack and what challenges for the implementation of an Enterprise Information Management strategy arise because of it?

2.2 Research Methods

In order to answer the aforementioned research questions and thereby reach the research objectives, multiple research steps are conducted in this thesis. This is visualised in Figure 2-1.

There are two main sources of information used in this study. The first research objective is reached by analysing the literature from relevant fields. To provide the context of the research, basic terms and definitions are described with the help of literature in the areas of Project Management and Collaborative Software in general and Collaborative Project Management Software as the focus of this study in particular. Subsequently literature in the field of Enterprise Information Management, particularly long-term information management, is researched, providing the information for the definition of needs and requirements.

A tool research is conducted to reach the second objective. As a first step a list of software tools that are currently available is compiled mainly with the help of web search and literature. The available tools are examined for how well they fit the definition of CPMS by screening them for the existence of a number of criteria that are based on the literature research. With this quantitative approach a subset of tools that best fit the targeted research area is selected.

These are then analysed in more depth, using free or test versions of the software, complemented by reports from practitioners, the tool's documentation and other literature. A list of the results of this analysis provides a basis for the assessment of the status quo.

The third research objective is addressed by using a qualitative approach in which the capabilities of the analysed software tools are compared with the previously defined requirements. The status quo of how the long-term information management needs and requirements are currently met is determined based on a comparison that aggregates the findings of the tool research and outlines the different levels of maturity in CPMS.

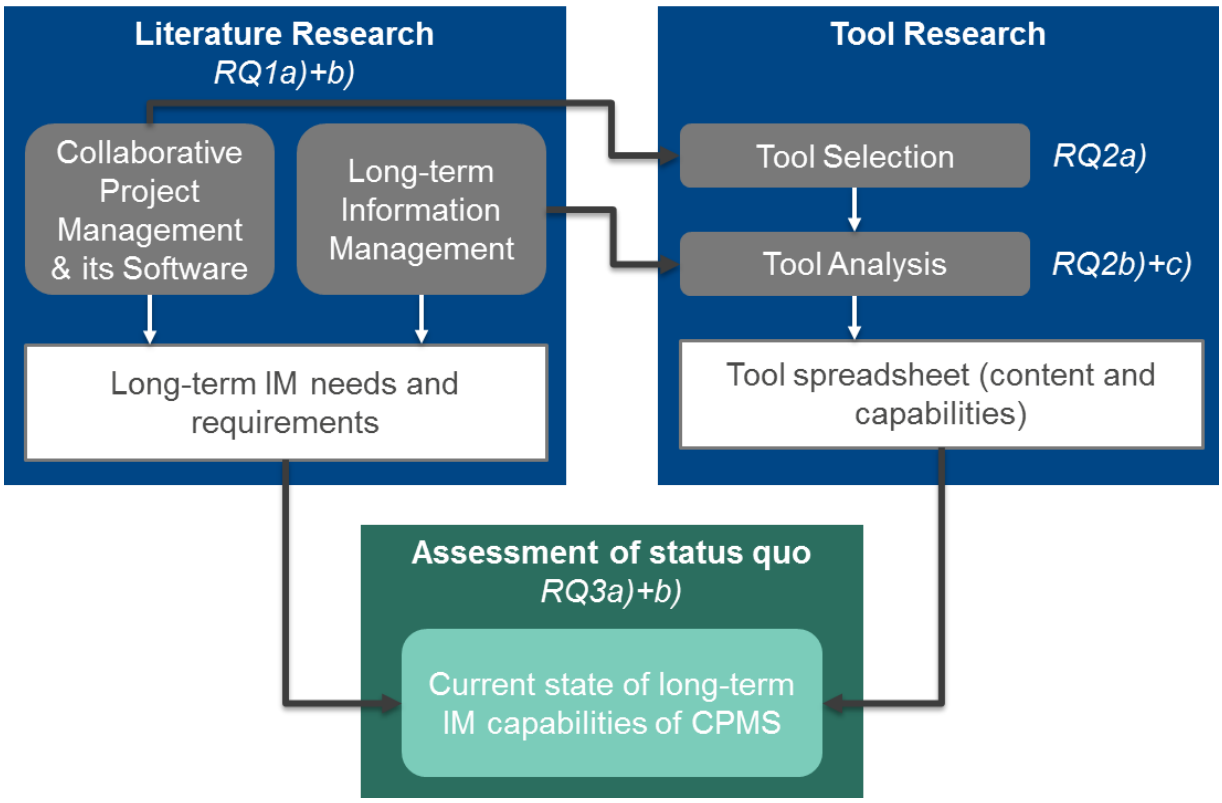


Figure 2-1: Research steps of this thesis

2.3 Scope and Limitations of the research

As stated above, this thesis will focus on the long-term aspects of information management and only on one type of software tool. This specific combination of research areas is chosen in consideration of the limited time and resources available for this thesis and because of the lack of research currently available. Even though the issues of long-term information management not only concern CPMS but other Enterprise Collaboration Software and Project Management Software as well, the types of content these systems contain are too different from each other to allow effective research on the current capabilities and challenges within this thesis.

The information management and project management practices can vary widely depending on the business environment. While an effort is made to include various business and regulatory needs, the different needs cannot be represented exhaustively within this study. As this thesis aims to find out capabilities, not to define the requirements for the development of a perfect CPMS, the definition of the requirements is not done in full accordance with the common practices in the field of requirements engineering, but rather just serves as an ascertainment of the needs that have been identified.

The scope of the tool research initially involves the identification of a large number of software tools that are currently available. Because the market of web-based project collaboration tools is expanding rapidly and the majority of tools is offered by startup companies rather than well-known software vendors, it is impossible to identify all of the relevant tools that are currently available. Therefore, as described above, a subset of tools is selected to represent a summary of the tools currently available. Even though an effort is made to select those tools that best fit the current understanding of Collaborative Project Management Software, the tool research does not aim to determine the 'best' CPMS in general, but instead focuses on the aspects of long-term information management.

The second part of the tool research, the detailed analysis of the tools that are selected, is limited by the fact that they cannot be tested in a real work environment. Only tools that are freely available or allow trial usage are selected for the tool research, so that this study does not completely have to rely on the information that is advertised by software providers on their websites and in their marketing. This of course limits the number of tools that can be tested, but the tool research shows, that a large enough number of tools are freely available. Of each tool the most comprehensive version was chosen to be able to assess the full range of functionalities. The analysis of the tools aims to determine the capabilities of the tools, so it is mostly about the availability of certain functionalities, which is why no scenarios are developed to reproduce a realistic work environment. It is worth noting that the applicability of the researched long-term information management capabilities in an existing business environment can differ vastly depending on the other software in use and the EIM measures already in place.

The tool analysis reveals that the use of an application programming interface (API) is one of the ways in which a CPMS can have long-term information management capabilities. How exactly the different requirements can be implemented with the help of an API and whether this would be feasible in view of the presumed effort and benefits will not be determined within this study, because it would involve more extensive research and would differ from case to case.

Despite these limitations, the research conducted in this study will contribute to a better understanding of how advanced the market for Collaborative Project Management Software currently is regarding the challenges of long-term information management.

3 Collaborative Project Management

As shown in section 1.1, the emergence of distributed projects has increased the need for collaboration in projects and within the last decade the paradigm of Project Management has shifted from a traditional approach towards a collaborative approach (Evaristo & van Fenema 1999; Chen et al. 2003). Following this paradigm, the activities that are typically associated with Project Management are explained in section 3.1, thereby providing the context for the functionalities supported by Collaborative Project Management Software.

In addition to the Project Management-specific functionalities, CPMS shares many functionalities with general Enterprise Collaboration Systems (ECS) or can even be seen as a special type of ECS. Therefore, in section 3.2 the area of Enterprise Collaboration Systems is introduced and this chapter is concluded by section 3.3, where a definition for Collaborative Project Management Software as it is used in this study is given.

3.1 Project Management and its Software

According to the Project Management Body of Knowledge (PMBoK) Project Management is "the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements." (PMI 2013, p.5). The PMBoK describes these Project Management-related tools and techniques and categorizes them in 5 process groups (Initiating, Planning, Executing, Monitoring and Controlling, Closing) and 10 knowledge areas (Project Integration, Scope, Time, Cost, Quality, Human Resource, Communications, Risk, Procurement, Stakeholder Management).

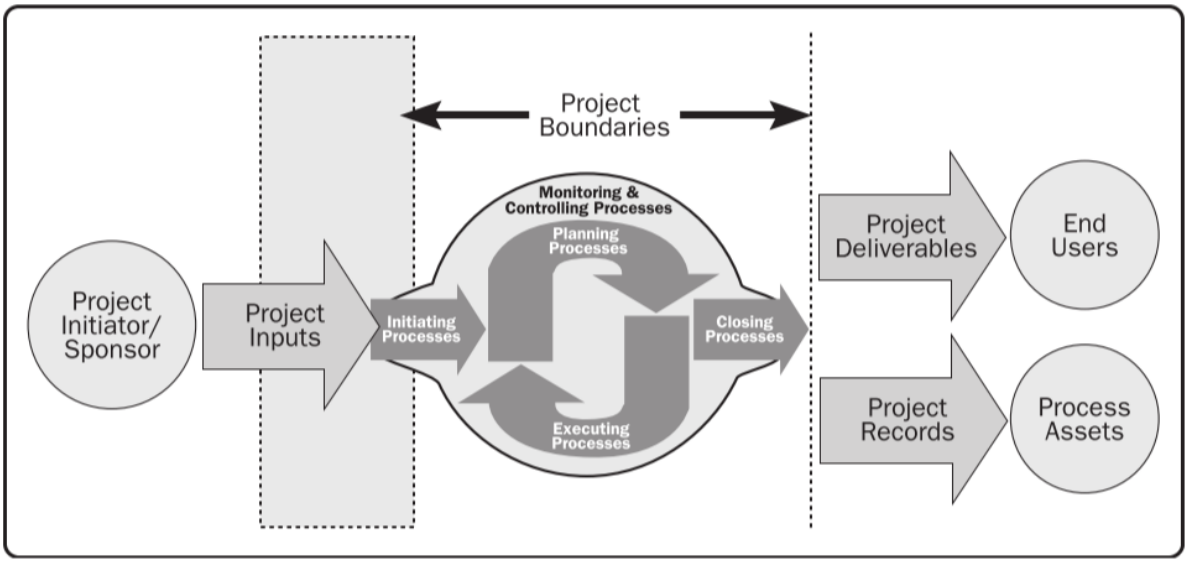


Figure 3-1: Project Management Process Groups and Project Boundaries (PMI 2013, p.54)

The boundaries of the project are defined as a part of the project charter to determine which project inputs are needed and which project deliverables and – particularly relevant for this study – project records must be generated (see Figure 3-1). As seen in table 3-1, the majority of Project Management activities are related to the planning and execution of a project. Additionally, the monitoring and controlling activities are ongoing throughout the entire project. Initiation and closing processes are only relevant at the beginning or end of the project or a project phase.

Knowledge Areas	**Project Management Process Groups**				
	Initiating Process Group	***Planning Process Group***	***Executing Process Group***	***Monitoring and Controlling Process Group***	***Closing Process Group***
Project Integration Management	Develop Project Charter	Develop Project Management Plan	Direct and Manage Project Work	Monitor and Control Project Work Perform Integrated Change Control	Close Project or Phase
Project Scope Management		Plan Scope Management, Collect Requirements, Define Scope, Create WBS		Validate Scope Control Scope	
Project Time Management		Plan Schedule Management, Define Activities, Sequence Activities, Estimate Activity Resources, Estimate Activity Durations, Develop Schedule		Control Schedule	
Project Cost Management		Plan Cost Management, Estimate Costs, Determine Budget		Control Costs	
Project Quality Management		Plan Quality Management	Perform Quality Assurance	Control Quality	
Project Human Resource Management		Plan Human Resource Management	Acquire Project Team Develop Project Team Manage Project Team		
Project Communications Management		Plan Communications Management	Manage Communications	Control Communications	
Project Risk Management		Plan Risk Management Identify Risks Perform Qualitative Risk Analysis Perform Quantitative Risk Analysis Plan Risk Responses		Control Risks	
Project Procurement Management		Plan Procurement Management	Conduct Procurements	Control Procurements	Close Procurements
Project Stakeholder Management	Identify Stakeholder	Plan Stakeholder Management	Manage Stakeholder Engagement	Control Stakeholder Engagement	

Table 3-1: PM Process Group and Knowledge Area Mapping (PMI 2013, p.61)

In the context of this thesis it is important to note that the PMBoK applies a broad definition of the term 'Project Management tool'. Especially in recent years a 'tool' is often automatically regarded to as computer based tool, while according to the PMBoK the term also includes analogue tools (Besner & Hobbs 2008).

The PMBoK also defines the flow of information within a project by providing a 3-step model similar to that of Data, Information, Knowledge and sometimes Wisdom, which is a common model in the field of information science (Bellinger et al. 2004; Wallace 2007):

- **Work performance data**, collected through controlling processes during the project execution.
- **Work performance information**, the analysis and aggregation of the collected data, brought into context with other project-related data.
- **Work performance reports,** the representation of the work performance information in the form of physical or electronic documents, like status reports, electronic dashboards and others.

The work performance reports then serve as a basis for decisions about changes to the project plan and are used in the communication with the project's stakeholders (PMI 2013, p.59). Apart from this short-term view on the management of project-related information, the PMBoK also defines some activities related to long-term information management, such as Records Management and Lessons Learned, which are discussed in chapter 4 of this thesis.

Desmond (2014, p.1) names the tools and techniques defined by the PMBoK, such as "the Project Charter, Work Breakdown Structure, schedule, plans for risk, quality, communications, people, scope, time and cost Management", as basic tools that most Project Managers nowadays are familiar with. Beyond these, she mentions a couple of tools that are not as common, but can also improve the Project Manager's effectiveness and that are not specific to a certain project domain. Some of these are: provisioning of templates, checklists and guidelines to support the creation of contracts, reports and documentations; supporting the processes for cost tracking, invoicing and payment; providing a project lifecycle chart to ensure that requirements of project gates are met.

Besner and Hobbs (2008) have conducted a study to determine the extent to which the Project Management tools described by the PMBoK are actually used by practitioners. Therein they identified eight functionalities of Project Management Software of which task scheduling, resource scheduling and schedule monitoring are among the most frequently used Project Management tools. Project Management Software has been in use for multiple decades and in its original form is often referred to as "Project Management Information Systems" (PMIS) which

are defined as “a system which supports and facilitates the delivery of any project, particularly those which are complex, subject to uncertainty, and under market, time and money pressures, or otherwise difficult to manage” (Jaafari & Manivong 1998, pp.1–2).

In contrast to this definition due to the increasing complexity in projects (see section 1.1), Besner and Hobbs (2008) as well as White and Fortune (2002) conclude that, while it is one of the most frequently used tools, Project Management Software often is not suited to support complex usages. PMIS are still mostly single-user systems and cover the areas described in the PMBoK as well as multi project purposes, such as project portfolio and program management (Ahlemann 2009). However, within the last decade the functionalities of Project Management Software have increased heavily, supporting many other PM activities and complex usage scenarios that have not been considered in the abovementioned studies.

Most Project Management activities are collaborative in nature due to the fact that they are rarely carried out by a single project manager, but rather by a team of project managers, a project management office (PMO), the whole project team or in communication with any of the project’s stakeholders (PMI 2013). Therefore, it could be argued that any software that supports collaboration can also be seen as a tool that supports Project Management. Following this notion, the different types of Enterprise Collaboration Software and their characteristics are presented in the next section.

3.2 Enterprise Collaboration and its Software

Following the emergence of Web 2.0 technologies and their adoption by enterprises, software that shares functionalities like chat, blogs, wikis, etc. has been referred to as “Social Software” or “Enterprise 2.0” when used in an enterprise context (Schubert & Williams 2013; McAfee 2006; Koch 2008). Differentiating the type of Social Software that is used in a closed environment within a company from outward-facing Social Media, which are publicly available platforms, Schubert and Williams (2013, p.224) give the following definition: „Enterprise Collaboration Systems are an emergent or more modern form of groupware enriched by the possibilities of the latest developments in technology (e.g. Web 2.0).” (see Figure 3-2).

Therefore, the theoretical foundation of Computer-Supported-Cooperative-Work (CSCW) applies to Enterprise Collaboration Systems (ECS) just like to previous types of groupware (Koch 2008). One fundamental concept in the field of CSCW is the 3C-Model, originally proposed by Ellis et al. (1991) and often applied or extended by other researchers in the field (Borghoff & Schlichter 2000; Fuks et al. 2005; Williams & Schubert 2011).

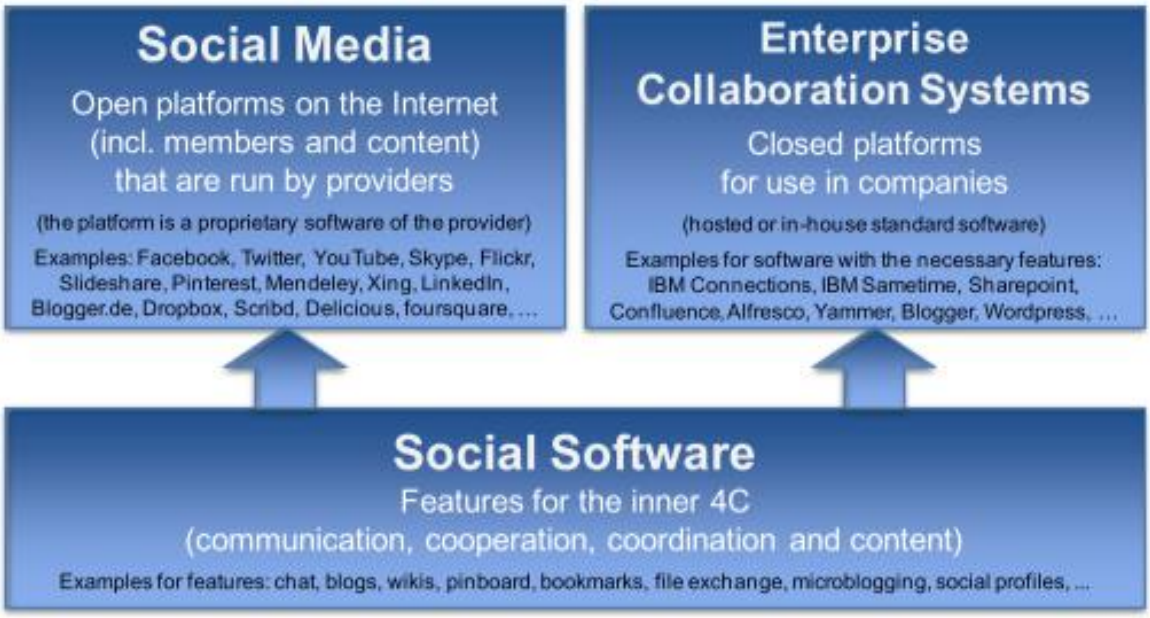


Figure 3-2: The relationship of Social Software, Social Media and Enterprise Collaboration Systems (Schubert & Williams 2013, p.225)

The 8C Framework by Williams and Schubert (2011), shown in Figure 3-3, adapts the 3C-Model for the context of Enterprise 2.0 by adding the activity "content/combination" to the existing three C's "communication", "cooperation" and "coordination". These four represent the core activities supported by Social Software. They are surrounded by four main areas of influence ("content management", "compliance", "change" and "contribution") which contribute to a company's Enterprise Information Management strategy.

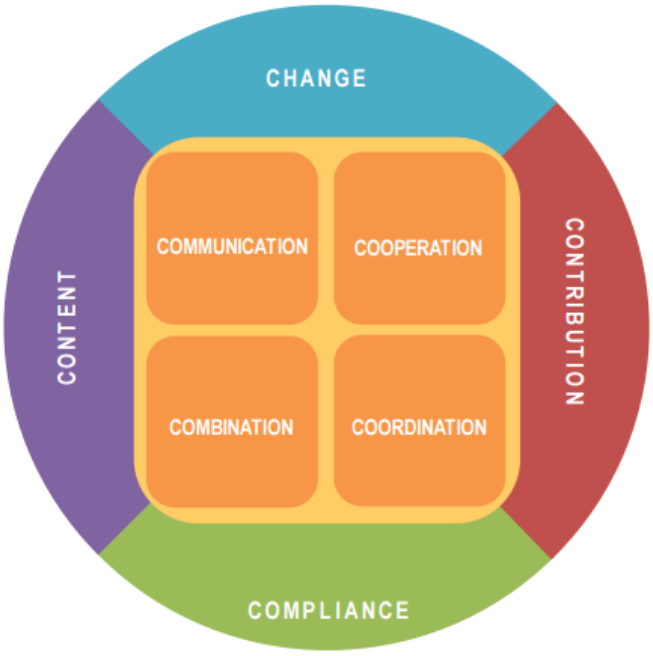


Figure 3-3: The 8C Framework for Enterprise Information Management (Williams 2011)

The following section describes how the inner core activities are represented in the context of Collaborative Project Management Software and chapter 4 elaborates on how the proximal influences, especially Content Management and Compliance, apply in the context of CPMS.

3.3 Collaborative Project Management and its Software

According to Jansson et al. (2009) there are two possible interpretations for the term "Collaborative Project Management" which both distinguish it from "Project Management" in its traditional sense (see Figure 3-4):

1. As mentioned in section 3.1, most Project Management activities nowadays are collaborative in nature rather than being carried out in a centralized, "top-down" manner. This leads to the interpretation as **"Collaborative Management of Projects"**.
2. With the emergence of distributed teams the project work itself has become more collaborative (see section 1.1), increasing the need to create and manage virtual organizations, which leads to the interpretation as **"Management of Collaborative Projects"**.

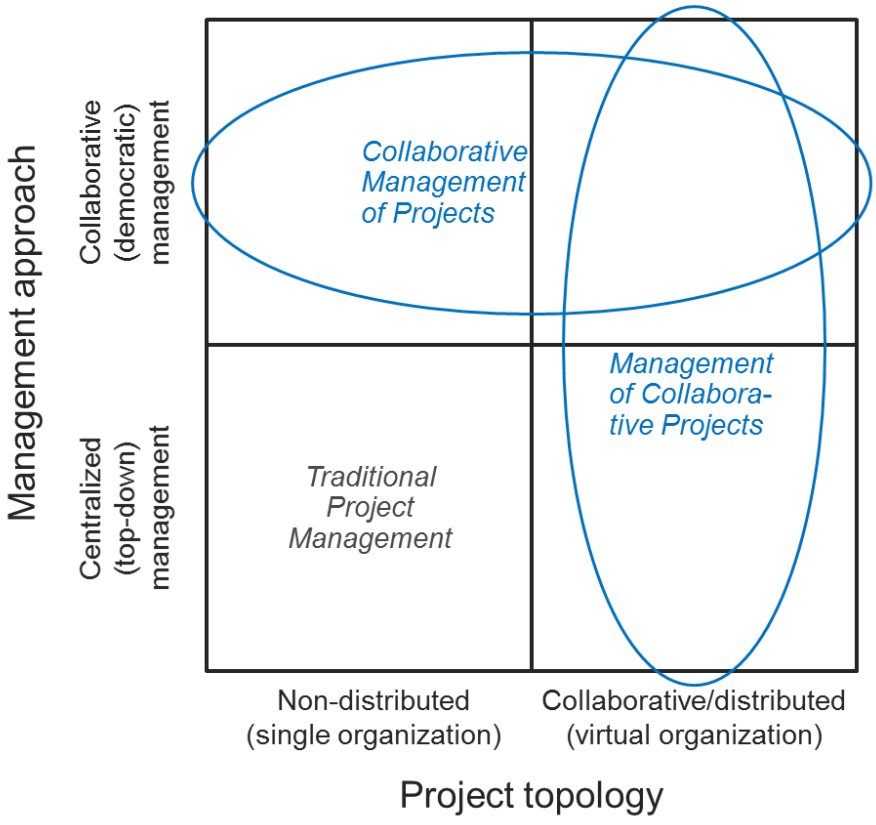


Figure 3-4: Two interpretations of "Collaborative Project Management" (adapted from Jansson et al. 2009)

These two interpretations are also reflected in attempts to define the term Collaborative Project Management Software (CPMS, often also abbreviated as CollabPMS). It cannot be strictly

defined as a certain type of software but rather is a segment on a spectrum between classical Project Management Information Systems (PMIS) and Enterprise Collaboration Systems (ECS), supporting both traditional Project Management activities and social or collaborative scenarios (see Figure 3-5).

Those CPMS closer to classical PMIS mainly support the Collaborative Management of Projects, by providing functionalities which help to carry out activities such as those defined by the PMBoK (see section 3.1). These systems are mainly used by project managers while the project team itself has no or only limited access to the software.

Those CPMS closer to ECS mainly support the Management of Collaborative Projects, by providing functionalities for all members of the project team as described by the 8C Framework shown in section 3.2. These systems further allow the project team to cooperate on project-related content and combine it with other content, communicate amongst themselves and coordinate their tasks.

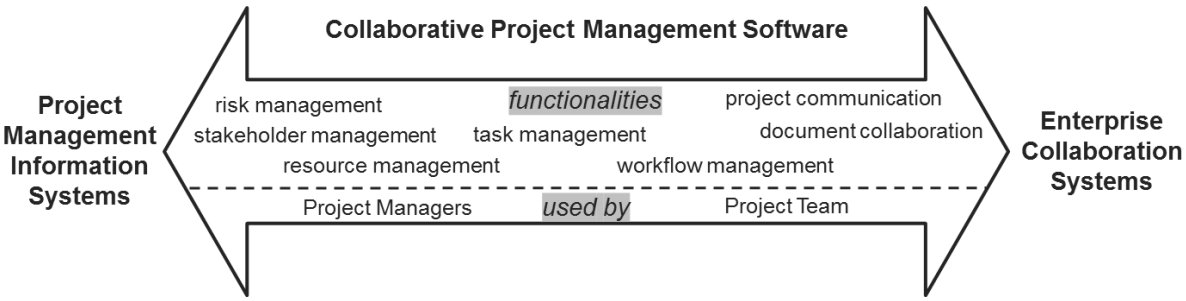


Figure 3-5: Range of Collaborative Project Management Software from classic Project Management Information Systems to Enterprise Collaboration Systems

An example of CPMS that provides a good middle way between both ends of the spectrum was given by Romano et al. (2002). They proposed a prototype Collaborative Project Management Software which contains modules that support both the Collaborative Management of Projects and the Management of Collaborative Projects and worked with this prototype in their research within the following years, leading to a comprehensive framework (Chen et al. 2003; Chen et al. 2006) for the support of Collaborative Project Management through information systems (see Figure 3-6). The framework contains four major groups of support functions:

- **Project Management Support**, mainly containing functionalities to support processes such as described by the PMBoK (see section 3.1),
- **Communication and Collaboration Support**, encompassing the support for the activities of the inner circle of the 8C Framework (see section 3.2),
- **Process Management Support**, supporting the efficient execution of project-related processes and increasing their transparency and

- **Knowledge Management Support**, with the aim of increasing project awareness and supporting the capturing and facilitation of all project-related knowledge.

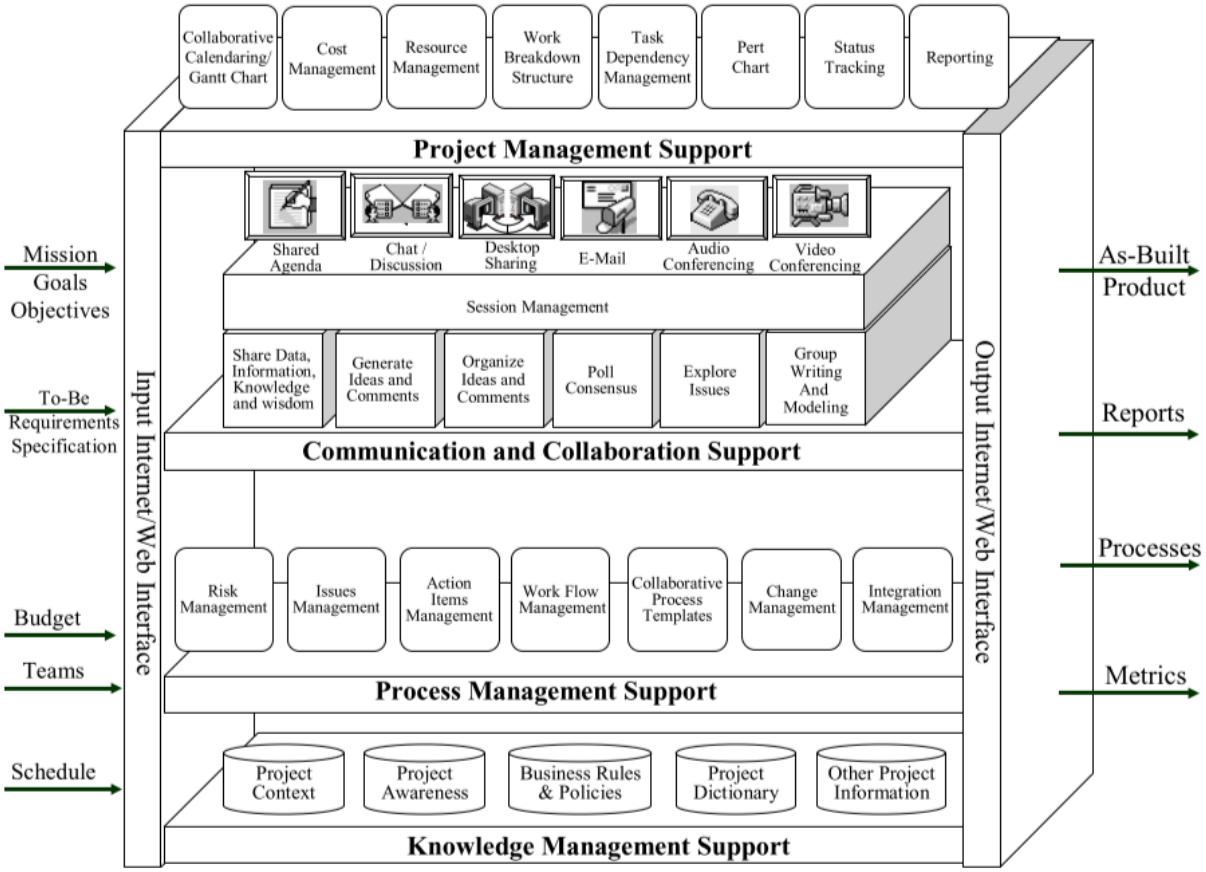


Figure 3-6: A collaborative project management Framework (Chen et al. 2006, p.10)

Nunamaker et al. (2002) propose a hierarchy of collaboration (see Figure 3-7) to classify the different levels of collaborative work that a team may require. Chen et al. (2006) used these levels to describe the different requirements for CPMS that project teams might have and their framework supports all levels of the hierarchy:

- At the level of **Collected Work** each team member works by himself and the result of the team's work is just the sum of the individual work. Project Management Software that supports this level of collaboration is close to PMIS on the abovementioned range.
- The level of **Coordinated Work** describes dependencies between the team member's tasks in the form of deliverables, hand-offs or milestones and thus requires a higher management effort that can be supported by CPMS.
- At the level of **Concerted Work** the performance of every team member affects the performance of the other team members and of the team in general. It requires a high amount of synchronisation of the team's work and supporting systems should allow for

asynchronous and synchronous communication, co-authoring and documentation of all tasks.

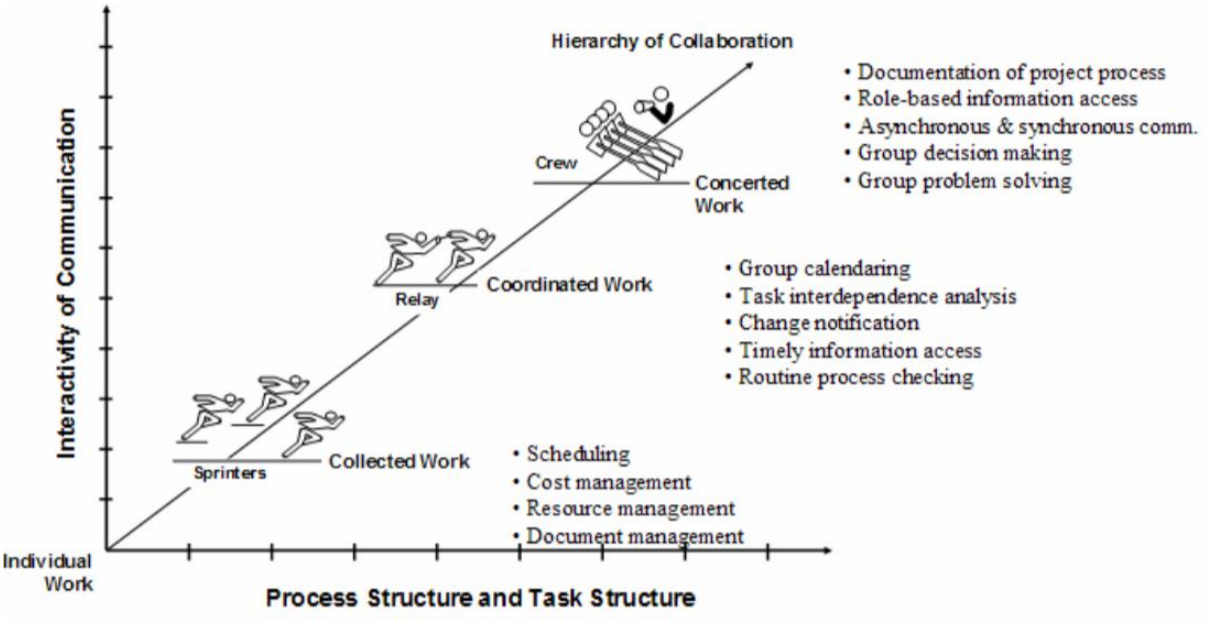


Figure 3-7: Hierarchy of collaboration in relation to requirements for task and process structure and requirements for interactivity of communication (Nunamaker et al. 2001b in Chen et al. 2006, p.4)

In chapter 6 the Collaborative Project Management Framework will be used to select those tools that support all three levels of collaboration. The following chapter will elaborate on the aspects of long-term management of the information that is generated in CPMS through the use of the abovementioned functionalities.

4 Long-term Information Management

As outlined in section 1.1, the management of content that is generated within collaboration software and especially in project environments is an important issue. According to the 8C Framework described in section 3.2 it is one of the proximal influences on Enterprise Collaboration Systems. This chapter provides an overview of current concepts in Enterprise Information Management and how these relate to Collaborative Project Management Software.

The management of information during a longer period of time, in the case of this study beyond the duration of a project is of particular relevance, both in regard to conformance and performance objectives. For example the long-term preservation of information can be required in order to meet compliance goals and project-related information can often be used to improve efficiency in following projects (Sydow 2004; Kasvi et al. 2003). The long-term management of information such as the project records described in section 3.1 is part of the concepts of the area of Enterprise Information Management which is introduced in the following section (4.1). Specific long-term information management activities in the context of this thesis are Records Management (4.2), Knowledge Management (4.3) and Enterprise Search (4.4). The concepts and practices described in this chapter serve as a basis for the definition of requirements for long-term information management in CPMS in chapter 5.

4.1 Enterprise Information Management

In order to holistically address the challenges that organisations face today, Gartner researchers defined the term Enterprise Information Management as “an integrative discipline for structuring, describing and governing information assets, regardless of organizational and technological boundaries, to improve operational efficiency, promote transparency and enable business insight” (Newman & Logan 2006, p.3). Thereby EIM should be implemented within organisations as an ongoing program that considers all sources of content and aims to implement an enterprise information architecture (Newman & Logan 2006). This thesis examines CPMS as one source of information that must be integrated within an organisation’s information architecture under consideration of the different EIM disciplines.

Especially the consideration of the different types of content that exist in an enterprise is important for the successful implementation of an EIM program. Olson (2009) gives an overview of categories of enterprise data (see Figure 4-1) that inherit different characteristics which influence the way the data can be managed. Highly structured information such as that from databases or transaction-based systems like ERP systems can usually be managed within these

systems across the whole lifecycle. In contrast, content like text documents (physical and electronic) or other file types (of specific applications) is regarded as semi-structured and more complex documents such as multimedia content are mostly unstructured. The management of these categories of enterprise data therefore requires a range of functionalities that are commonly summed up under the term Enterprise Content Management (ECM) (Datamonitor 2009).

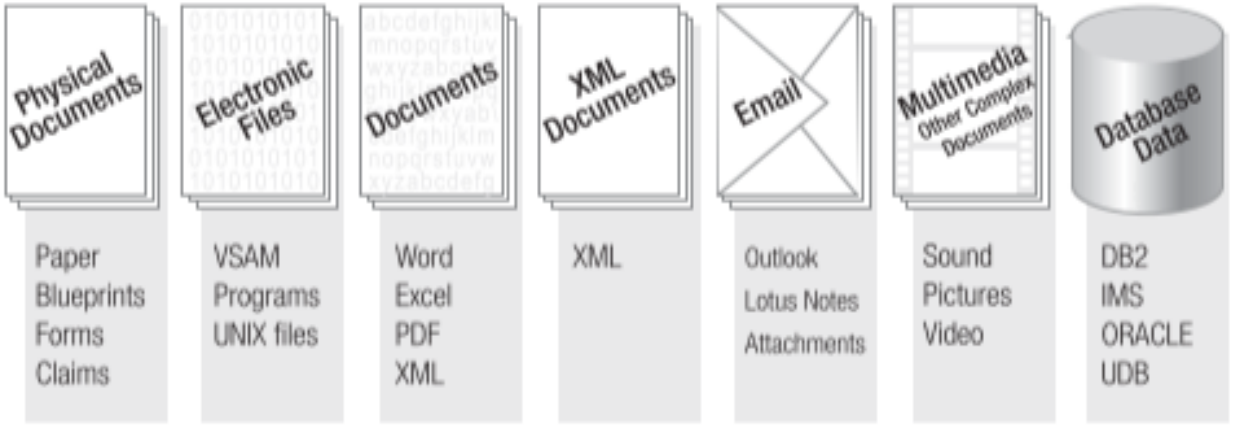


Figure 4-1: Categories of enterprise data (Olson 2009, p.6)

Figure 4-2 shows the different components of the broader Enterprise Content Management ecosystem, including Enterprise Collaboration Software that is discussed in section 3.2 and Knowledge Management and Enterprise Search which are introduced in sections 4.3 and 4.4. The boundaries between these applications and the traditional area of Documents and Records Management (DRM) are becoming more blurred with the use of Document management functionalities in Collaboration Software and vice versa (Datamonitor 2009). Document management systems in the narrower sense, focussing on file-based text documents, include functionalities such as:

- search and navigation,
- check-in/check-out,
- version management,
- visualization of the content, for example in folder structures (Kampffmeyer 2006) and
- workflows based on rules and metadata (Benevolo & Negri 2007).

Another component that is increasingly being implemented in DRM systems is workflow and business process management which enables the automation of document-related tasks, as approval or publishing, for example. As a special form of DRM, digital asset management components include the abovementioned functionalities with the focus on multimedia content which is also referred to as rich media documents (Kampffmeyer 2006).

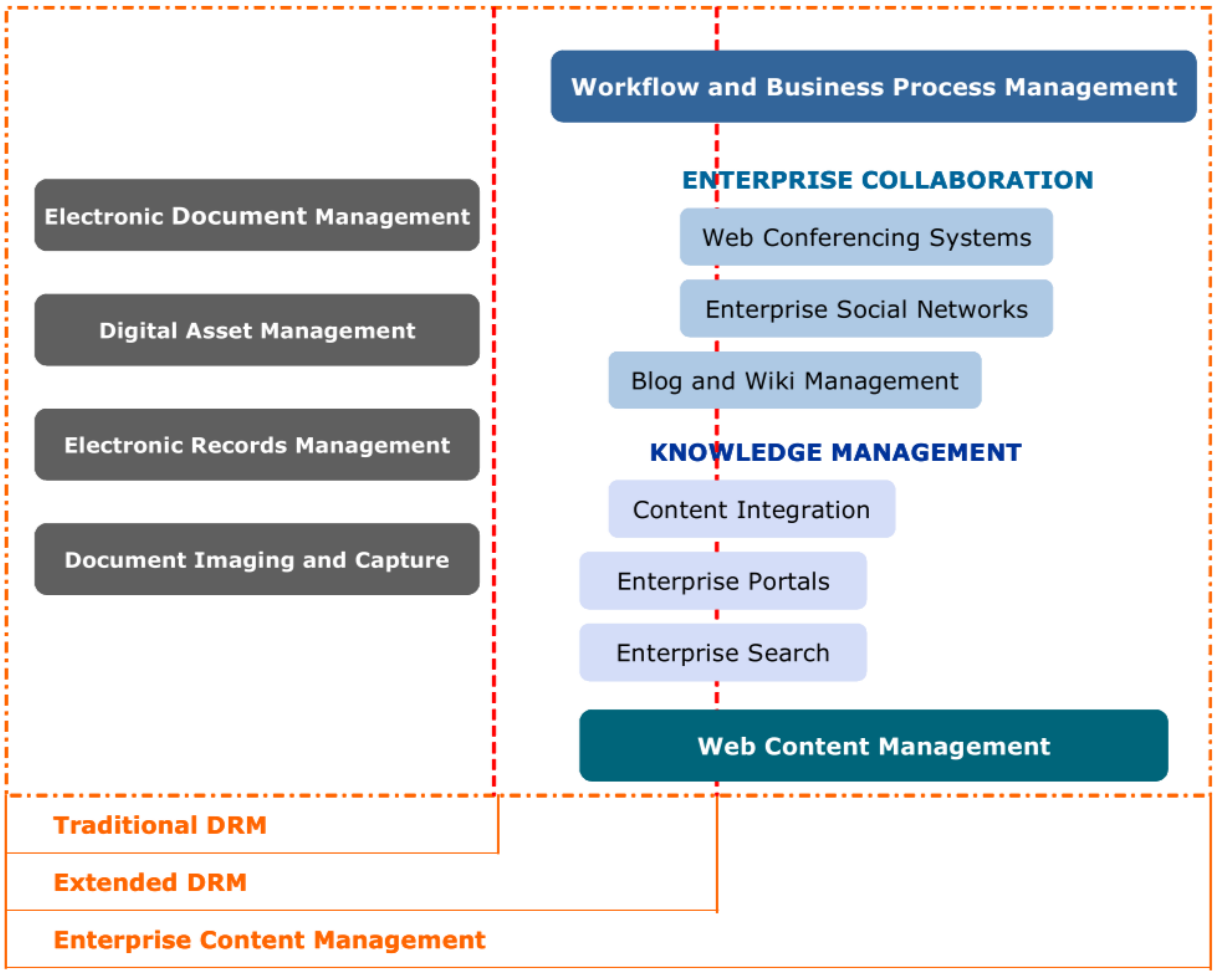


Figure 4-2: Components of the Enterprise Content Management ecosystem (Datamonitor 2009, p.28)

In a broader sense, beyond text or media documents, the term digital business document is used to describe all electronic documents that need to be managed in a business environment. Hausmann and Williams (2015, p.362) define digital business documents as "electronically stored semi-structured information, which extend our knowledge by supporting business communication, informing stakeholders and/or showing evidence of business activities."

Another example of a digital business document is mentioned by Olson (2009) with E-Mail (see Figure 4-1). This category of enterprise data is also less well-structured and nowadays has expanded beyond E-Mail, including many kinds of content that originate from communication or collaboration between users. With the emergence of Enterprise Collaboration Systems a special subset of digital business documents has come up which is called social business documents. They originate from collaboration features in ECS and are compound documents that aggregate different social contents, similar to how an E-Mail can be a compound document of text and attachments. Examples for social business documents are wiki entries, discussion/forum posts, blog posts or status messages (Hausmann & Williams 2015).

It is important to note that not all content that is generated by collaboration features is a social business document. Table 4-1 shows examples of social content that on its own has no meaning but instead must always be considered in the context of other content. For example, a blog post is a compound document of the main content, enhanced with likes, tags or comments, thus becoming a social business document (Hausmann & Williams 2016).

Name	Description	Purpose/Aim	Why it is not a social document
Like	Expression of favor for some specific information	Recommend content; Shows consent	If seen alone the context of the like is gone and it no longer relates to any information. All likes are the same, the difference is in what someone likes. When attached to a wiki entry as an example, it becomes part of that social document
Tag	A keyword or index term attached to other documents	Clustering content for better resource discovery	A tag alone is just a word and has no context or explanatory power. It becomes part of a social document when it is attached to it and is rather a special kind of metadata.
Comment	Written annotation related to another social document	Adds opinion, concerns or ideas to something	A comment itself might include important information and could be seen as a document. However, comments are always attached to something and thus are a contextual component of a social document.

Table 4-1: Examples of attached social content (Hausmann & Williams 2016, p.48)

Hausmann and Williams (2016) also note that, while most social business document are created in ECS and thereby inherit the characteristics from the beginning (born-social), more traditional documents like text documents can become social business documents when they come into contact with collaboration features (become-social). This is a relevant factor for the CPMS examined in this thesis, of which many contain some sort of a document management component.

Hausmann and Williams (2015, p.362) note in their definition of digital business documents that "independent of their format, but dependent on their purpose, digital business documents pass through different phases during their lifecycle (creation, use and disposition) and have different phases in which they need to be managed." Figure 4-3 gives an overview of the information design and management activities in the different stages of the information lifecycle, which are permanently accompanied by information governance activities (Williams 2016):

- A document is either created by authoring in a document management system or another application or it is capture, for example through document imaging, which is another component of traditional DRM (Datamonitor 2009).

- Subsequently it is described and organised with the help of metadata and can be retrieved for use by other users (see section 4.4.). A special case of the use is re-use, when a document or parts of it are used to create new content, which then enters the lifecycle anew.
- Eventually a document is no longer actively used and it has to be evaluated how the document disposition should be handled. A document can either be destroyed (deleted) or retained, often by using an Archiving or Records Management system.

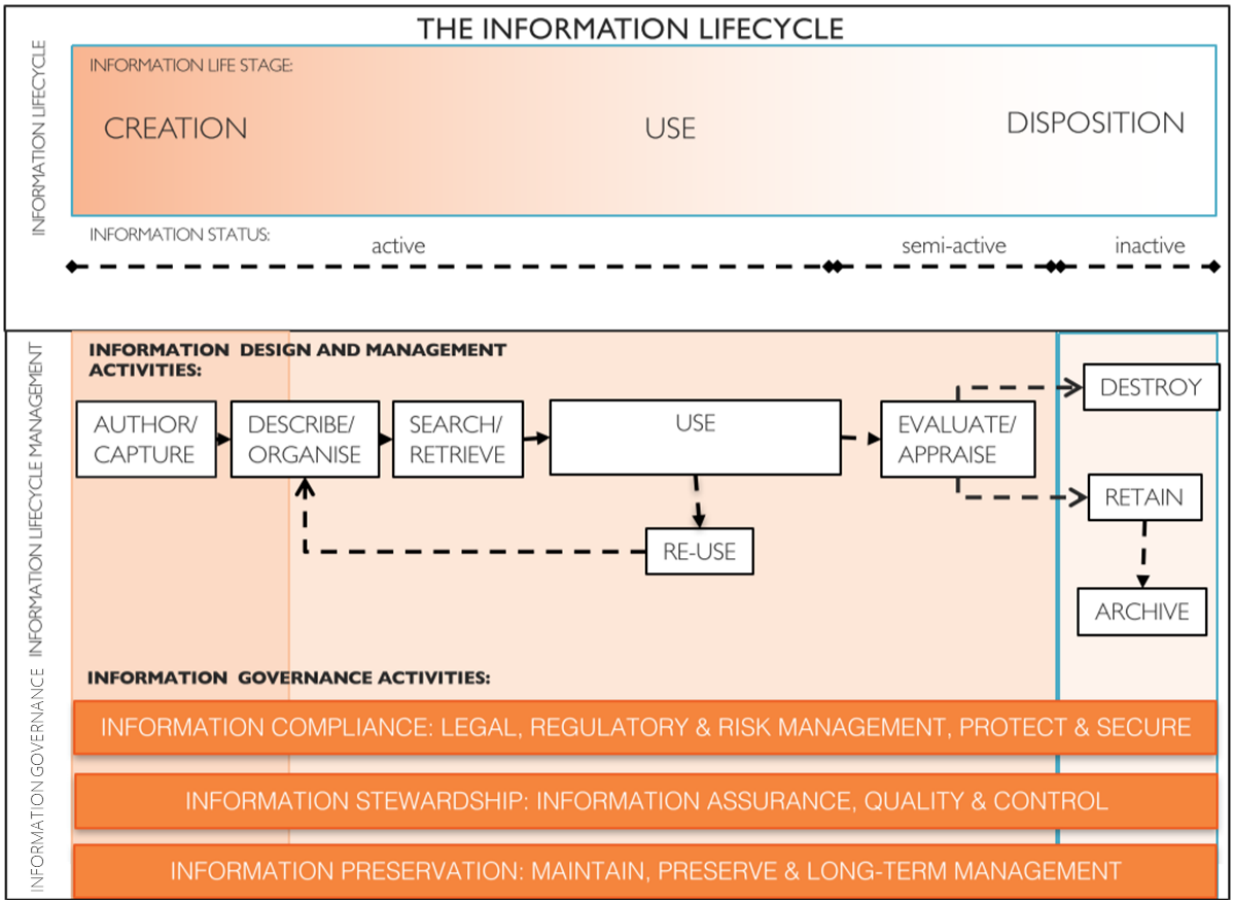


Figure 4-3: The information lifecycle (Williams 2016)

Records Management is another of the main components of the abovementioned area of traditional DRM and one of the fundamental long-term information management activities. The following section elaborates on the central concepts and models that are relevant in this last stage of the information lifecycle.

4.2 Records Management

It is important to address the disposition of a document in order to increase the efficiency of the information system, avoid risks and ensure compliance with regulations and laws (Hengeler Mueller 2013). Documents are declared as a record when they should be retain for later reference after they have become inactive. The ISO 15489-1 (2016) norm on records management defines a record as "information created, received and maintained as evidence and as an asset by an organization or person, in pursuit of legal obligations or in the transaction of business". Records are comprised of content, context (indicating the relations of the content) and structure (the way content and context are laid out and made interpretable) which are sufficient to provide evidence of the legal obligation or business transaction (ICA 1997). Therefor records inherit the following qualities (JISC n.d.):

- "Authenticity. It should be possible to identify, and preferably prove, the process which created the record and who its authorised creator was
- Completeness. The record should contain all of the content required to act as evidence of the transaction it is documenting. This does not mean that one record must contain everything to which it relates; simply that it is complete in its own terms
- Reliability. It is important that the content of the record can be relied upon as an accurate representation of the transaction it is documenting
- Fixity. Once declared as a record its content should no longer be altered or changed in any way. It is in this way that its evidential value is preserved (by ensuring that the content of a record remains exactly as it was at creation)."

While many records originate from normal business activities, there can also be records that originate from a project environment. According to the PMBoK "project records may include correspondence, memos, meeting minutes, and other documents describing the project. This information should, to the extent possible and appropriate, be maintained in an organized manner. Project team members can also maintain records in a project notebook or register, which could be physical or electronic" (PMI 2013, p.302). All kinds of digital business documents as defined in the previous section can be declared as records.

Figure 4-4 shows examples of different types of records, ranging from traditional documents, over social business documents like blog posts or comments to rich media content like images (Datamonitor 2009). Based on metadata associated with the document the decision to declare a document as a record is made based on the classification of the document and in accordance to policies which define certain criteria and are often represented in the form of a file plan

(Beigi et al. 2005; Petrocelli 2005). Also based on this, a retention and deletion schedule is assigned to the record, defining its further disposition (Kampffmeyer 2006) and an audit trail of the record is maintained that tracks all changes made to the record in order to maintain the quality of authenticity (JISC n.d.).

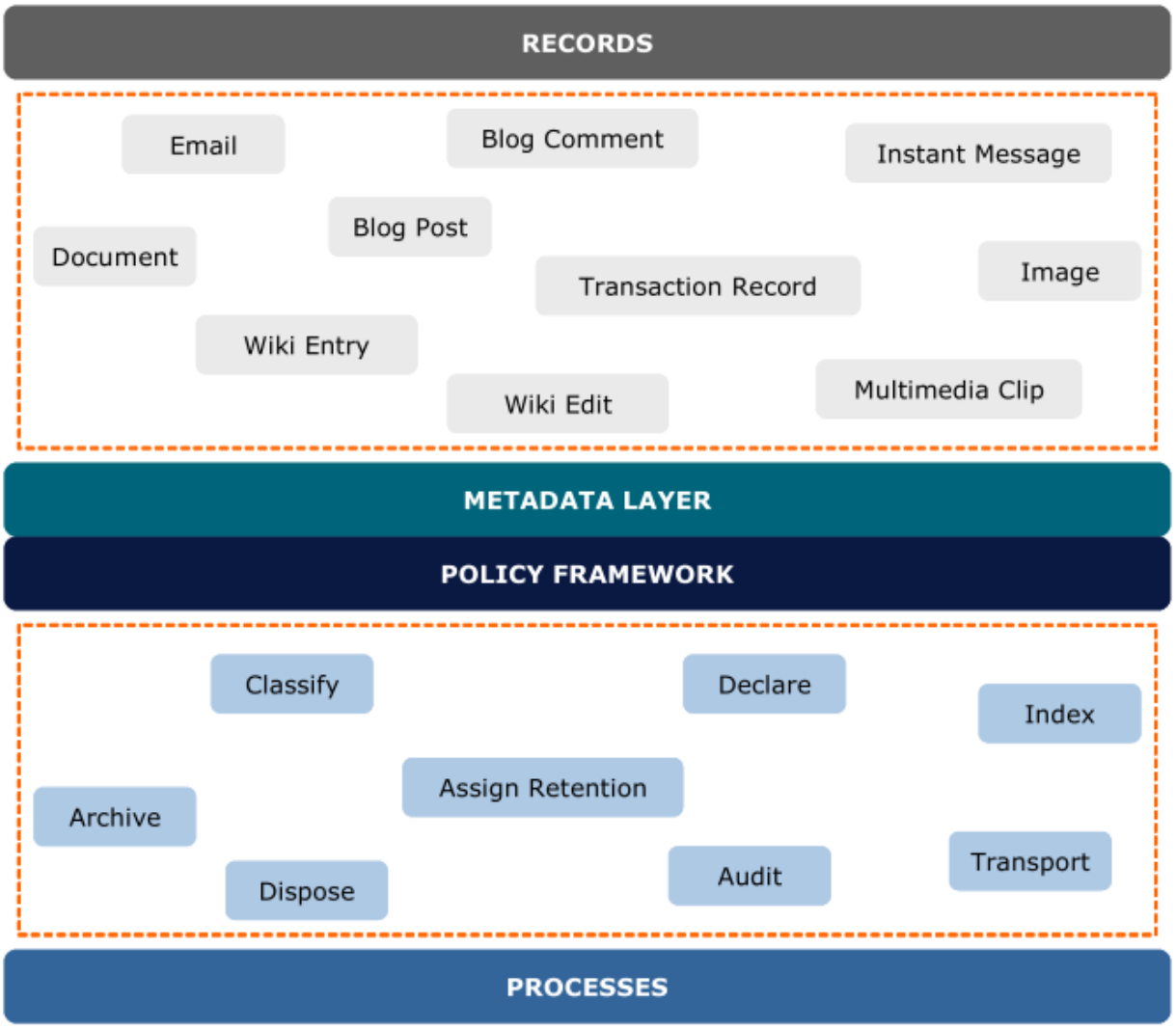


Figure 4-4: Records and the associated metadata are used to apply policies that prompt Records Management processes (Datamonitor 2009, p.29)

Often companies follow the strategy of archiving all their information, not only the information that they are required to retain by compliance standards, which the Datamonitor report (2009) calls 'manage-everything-as-a-record' paradigm. This can be an easy way of retaining the company's knowledge, but – let alone possible overheads in cost and effort – this over-retention also comes with the risk of creating unnecessary vulnerability against investigatory audits, prosecution and the potential loss of reputation (Hengeler Mueller 2013; Williams & Hardy 2011). A better way to retain a company's knowledge is to implement Knowledge Management strategies for the creation of knowledge artefacts, which will be described in the following section.

4.3 Knowledge Management

In projects across many different industries knowledge about the management of the project as well as the technical issues underlying the project is vital and therefore is considered a critical resource in project-based organisations (Madani 2013). That implies that this knowledge must be managed, just as other business-critical resources such as records.

Among the most common frameworks for the development of Knowledge Management (KM) strategies is the SECI-Model by Nonaka and Takeuchi (1995), which introduces the concept of tacit and explicit knowledge. Tacit knowledge is passed on from person to person via socialization and is converted into explicit knowledge via externalization, for example by capturing it in some form of knowledge repository. Explicit knowledge then is combined with other explicit knowledge and internalized by persons, thereby becoming tacit knowledge again (see Figure 4-5).

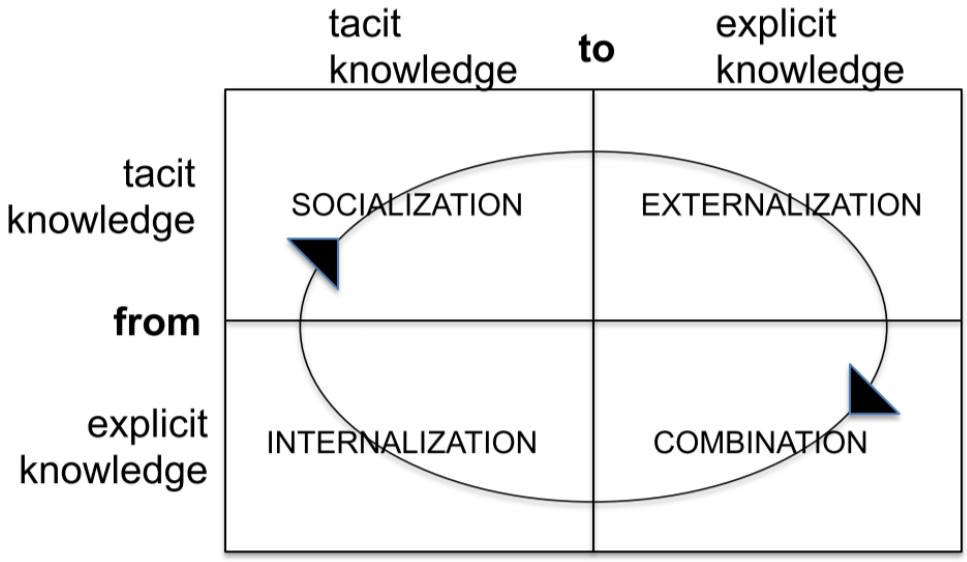


Figure 4-5: SECI Model (adapted from Nonaka & Takeuchi 1995)

Another important concept in the area of KM strategies is the differentiation between Personalization and Codification strategies (Hansen et al. 1999). A Personalization strategy focuses on the management of tacit knowledge and enabling person-to-person communication as a means of knowledge sharing. The role of information technology – in the context of this thesis: the role of CPMS – is to facilitate communication between members of the project team and enable them to collaborate and find experts on certain topics. A Codification strategy on the other hand emphasises the creation of explicit knowledge in the form of knowledge repositories (wikis). Here the role of IT is to provide these repositories and to support the process of codification.

According to the definition of EIM from Newman & Logan (2006), the scope of an EIM program is limited to 'information assets' – the explicit forms of knowledge – while a knowledge management program considers all 'intellectual assets', including the tacit forms of knowledge. Therefore, and because any collaborative software naturally supports the exchange of tacit knowledge, this thesis focuses on how Codification strategies are supported by CPMS.

A distinction can be made between Knowledge Management within a single project and Knowledge Management beyond the borders of one project. The latter is particularly important for project-based organisations. In addition to the actual product or service, according to Kasvi et al. (2003) any project has another important output, which is project knowledge related to the product, its production and use. This includes technical, procedural and organisational knowledge. Within project-based organisations it is problematic that project knowledge is not always used within future projects and thus the same mistakes are made multiple times (Prusak 2009).

An important concept to counteract this problem are Lessons Learned. The PMBOK defines Lessons Learned as "The knowledge gained during a project which shows how project events were addressed or should be addressed in the future with the purpose of improving future performance" (PMI 2013, p.544). The generic Lessons Learned process as described by Weber et al. (2001) shown in Figure 4-6 basically covers all areas of the SECI Model (see Figure 4-5).

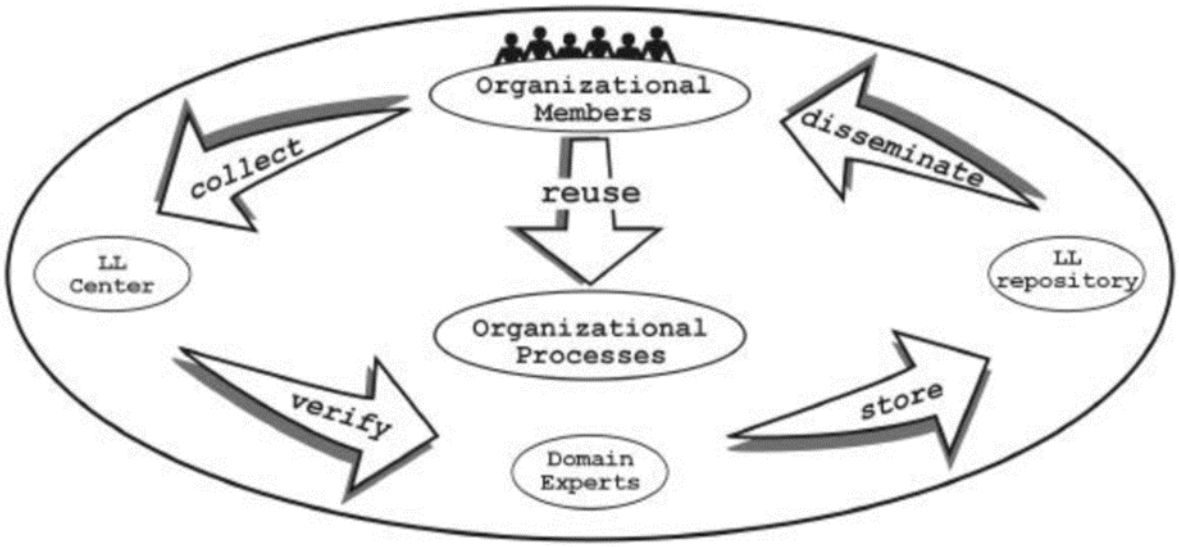


Figure 4-6: A generic Lessons Learned Process (Weber et al. 2001, p.8)

Employees gather in Lessons Learned sessions to collect their experiences and share them amongst each other (**Socialization**) and to store them as explicit knowledge (**Externalization**). When similar information has been captured in earlier sessions, it can be combined with the new information and can be verified (**Combination**). The Lessons Learned that have been captured are then disseminated to the other organisational members and can be reused in order

to improve future activities or decisions (**Internalization**). As mentioned above, the role of IT is to provide some sort of repository to support the Codification/Externalization of the Lessons Learned and to make them available for future use.

Because of the importance of Knowledge Management within a project and among multiple projects, the support of Knowledge Management is one of the four main support groups defined by Chen et al. (2006) in the CPMS framework (see section 3.3). Therefore, the Tool Analysis in the next chapter will examine in which ways the selected software tools support the creation and dissemination of Lessons Learned and other knowledge artefacts within a single project and between multiple projects.

4.4 Enterprise Search and e-Discovery

In addition to finding information through previously created knowledge artefacts, such as Lessons Learned, employees often require the assistance by a search engine to find specific information. This is the subject of the research field of Information Retrieval (IR) which Manning et al. (2008, p.1) define as "finding material (usually documents) of an unstructured nature (usually text) that satisfies an information need from within large collections (usually stored on computers)." Information Retrieval technologies that are applied within organisations are known under the term Enterprise Search (Hawking 2010). Enterprise Search software can assist the user in finding the right information in an efficient manner. Hawking (2004, p.15) gives a good definition of what Enterprise Search systems include:

- "search of the organisation's external website;
- search of the organisation's internal website (its intranet);
- search of other electronic text held by the organisation in the form of email, database records, documents on fileshares and the like."

As shown in section 4.1, nowadays other social content beyond that in E-Mails and in traditional intranets, for example that in Collaborative Project Management Software, has gained relevance and thus should be retrievable by Enterprise Search systems.

According to White (2015) Enterprise Search should be seen as a business-critical application, because it plays an important part in decision support in all types of companies and the only two important metrics for measuring its success are user-acceptance and the impact on business performance. Thus, White's definition does not only include the functionalities of Enterprise Search but also the values, it generates: "Enterprise Search is a managed search environment that enables employees to find information they can rely on in making decisions that will

achieve organizational and personal objectives" (White 2015). In the context of Project Management this is specifically relevant over a longer term when employees need to find information about previous projects that can be relevant for current projects or other business decisions.

While Enterprise Search technologies are often included within Enterprise Content Management Systems, they can also exist as stand-alone solutions, connecting to various information systems within the enterprise (Andrews & Koehler-Kruener 2015). Therefore, at the core of most Enterprise Search technologies a method called federated search is used to connect the different information sources existing in company (also called information silos). By leveraging the indexes and search engines of the different information sources or creating own indexes, the main (federated) search engine can provide search results from all of the company's information sources and display them in a unified user interface, either combined with each other or categorized according to their source (see Figure 4-7). To connect to the different information sources, most of these sources provide standardized connectors (Fallmann 2015).

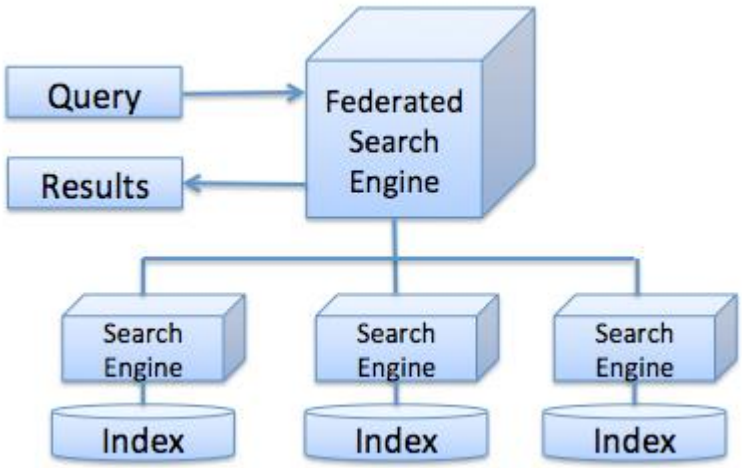


Figure 4-7: The structure of a federated search engine (McKnight 2010)

Enterprise Search technologies are also connected to the topic of Business Intelligence and play a particularly important role in e-Discovery Software (Andrews & Koehler-Kruener 2015; Hawking 2010; White 2015). The financial and reputational risk of not being able to find all relevant electronically stored information in a legal discovery process mandates the ability to search all of an organisation's electronic repositories, including, for example, stand-alone Collaborative Project Management Software (White 2015). Therefore, the use of federated search technology should be possible. E-Discovery does not only include the retrieval of information that is relevant to a legal case, but also the management of the information, as shown by the definition

of e-Discovery: “The process of identifying, locating, preserving, collecting, preparing, reviewing, and producing Electronically Stored Information (ESI) in the context of the legal process” (Harris & McVoy 2014, p.15). This is another reason why – as described in sections 4.1 and 4.2 – all information should be proactively managed across its entire lifecycle and a Records Management strategy should be in place (AIIM n.d.).

5 Summary of long-term information management requirements

The previous chapter introduced the field of Enterprise Information Management and therein special topics of long-term information management on a mostly theoretical level. From the concepts and frameworks requirements that Collaborative Project Management Software must fulfil in order to inherit sufficient capabilities for the long-term management of information can be derived. These requirements are summarized in this chapter to use them in the following tool analysis as well as for the evaluation of the status quo in chapter 7.

Williams et al. (2014) propose that the drivers of EIM programs in a company are mostly geared towards two objectives:

- Performance: deriving greater business value and meeting business objectives and
- Conformance: meeting compliance requirements and protection of information assets.

This distinction can also be made for the requirements for long-term information management. The requirements from the field of Records Management are mostly geared towards **conformance objectives**, by ensuring the compliance with laws and regulations. Similarly, e-Discovery aims to fulfil legislative requirements in the case of legal disputes and therefore requires sufficient information retrieval capabilities.

With regard to Enterprise Search these capabilities are also relevant for meeting **performance objectives**. According to Williams et al. (2014, p.10) “the most important drivers are closely linked […] to obtain greater value from information by improving the organization’s ability to access and share information, to re-use information and gain business intelligence.” In addition to Enterprise Search, this shows the need for general document management functionalities that allow creation or capturing of information, its storage and collaboration on it. Likewise, Knowledge Management activities mainly aim to improve business performance; in the context of this thesis particularly through improving the performance of projects by applying the Lessons Learned from previous projects.

Since some of the abovementioned objectives may possibly be conflicting, a balance must be found between generating business value and meeting compliance requirements (Williams et al. 2014) which is taken into account in the evaluation of the status quo in chapter 7. Furthermore, some functionalities may only be required if certain types of content exist in the system. For example, not all CPMS necessarily allow the storage of files, therefore there is no need for the capability of searching through files or assigning them to a retention schedule. Within the tool analysis (section 6.2) the types of content that occur in each tool are identified to be able to determine which requirements apply in each case.

Table 5-1 displays the requirements in the different areas of long-term information management that apply for Collaborative Project Management Software and that have been aggregated based on the literature research in the previous chapters. All requirements (except for those in the area of Knowledge Management that partially refer to newly generated content) generally apply to all types of digital business documents as defined in section 3.1. These requirements are the foundation of the tool research conducted in the following chapter.

Area of long-term information management	#	Requirement
General Enterprise Information Management	1.1	Versioning of document
	1.2	Automatic assignment of metadata such as author, date, etc. to document
	1.3	Possibility for users to assign descriptive metadata to document
Records Management	2.1	Ability to extract digital and social business documents as compound documents of different content
	2.2	Declaration of the document as a record based on retention and deletion policies
	2.3	Possibility to maintain audit trail of record
Knowledge Management	3.1	Creation, storage and dissemination of knowledge artefacts such as Lessons Learned
	3.2	Re-use of project-related content in creation of knowledge artefacts
Enterprise Search/ e-Discovery	4.1	Indexing of all relevant content
	4.2	Possibility to connect federated search engine
	4.3	Ability to preserve content in case of legal hold

Table 5-1: Requirements for long-term information management in CPMS

6 Tool Research

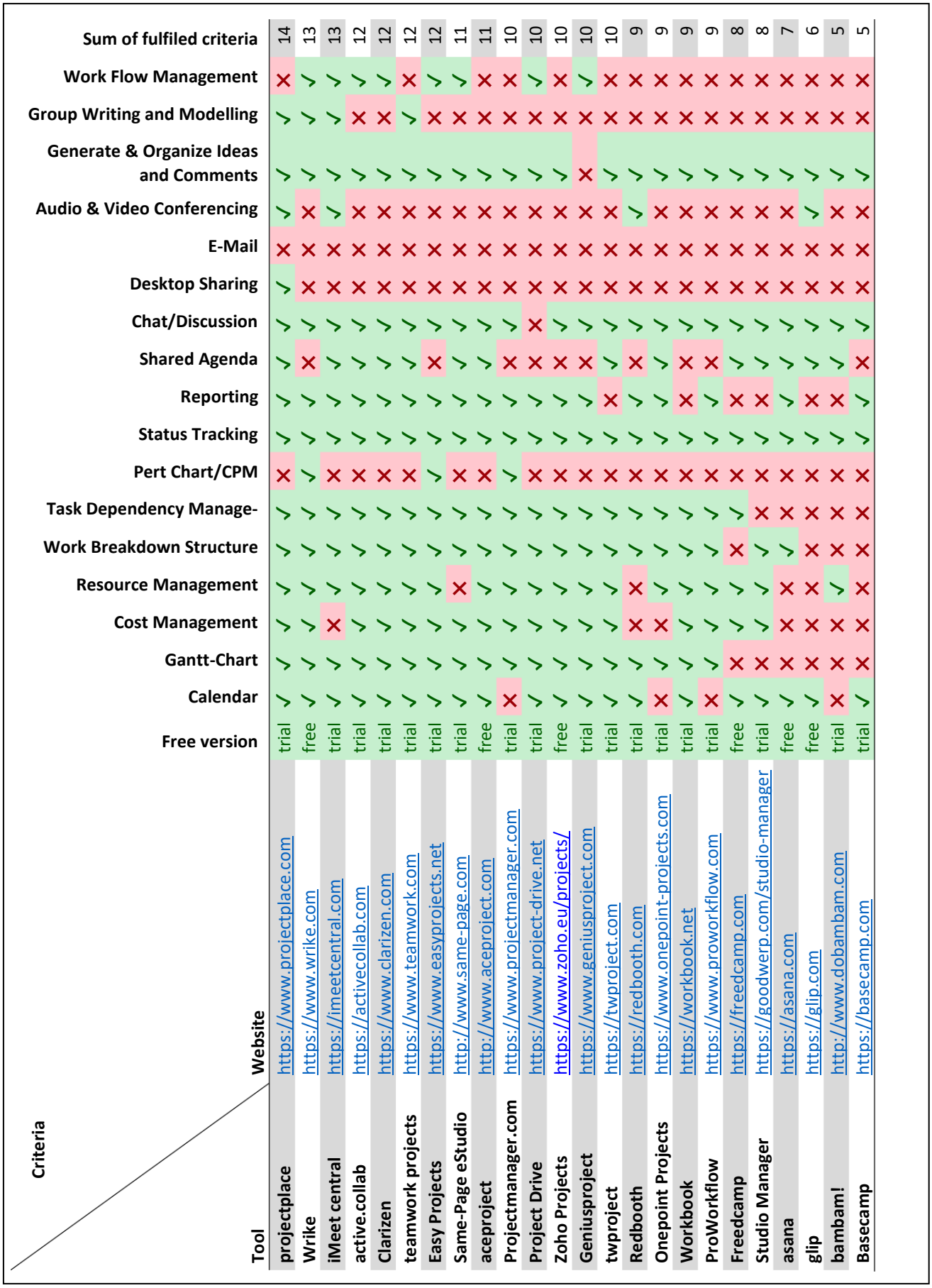
As shown in section 3.3 software tools cannot be easily categorized as Collaborative Project Management Software, because most of them include functionalities of other software types as well. Therefore, in the following section 46 software tools are examined in order to determine their functionalities and to then select a subset of those that best fit the targeted research area. Following this, the selected subset of the examined tools is analysed more in-depth as a basis for the evaluation of the status quo in chapter 7.

6.1 Tool selection

The Gartner Magic Quadrant reports for Cloud-Based IT Project and Portfolio Management Services and for IT Project (Stang et al. 2016a) and Portfolio Management (IT PPM) Software Applications (Stang et al. 2016b) describe the market for IT PPM software as “messy”, “because it provides long-term and short-term buying options” in the form of on-premises and cloud-hosted solutions. The Magic Quadrants each only feature the 10 most widespread tools. The Software Advice (2017) tool for selecting web-based Project Management Software from March 2017 lists 108 non industry-specific systems, although not all of them are collaborative in nature. The focus of this thesis lies on the cloud-hosted solutions, but goes beyond the IT-project and enterprise focussed solutions featured in the Magic Quadrant.

In addition to web search multiple sources about Project Management Software (Miller 2008; Stang et al. 2016a; Wikipedia 2017; Ueland 2013) served as a starting point for the tool research to define a list of tools that should be examined towards their fit as a CPMS. In a first step the websites and documentations of the vendors where reviewed and those tools that do not offer sufficient collaborative functionalities, sufficient Project Management capabilities or that are only meant for a niche market (e.g. software development, like Jira) were not considered any further. Those tools that do not provide a possibility for more detailed analysis via a free or trial version of the product were also omitted. In this process 26 software tools were identified (see first column of Table 6-1) for closer examination of their respective websites and other marketing materials.

The tools were subsequently checked for a number of criteria (see first row of Table 6-1). The criteria are based on the functionalities of CPMS described in section 3.3, particularly the CPMS Framework developed by Chen et al. (2006). Most of the criteria from the Process Management Support level are left out, because they are usually not fulfilled by a specific software feature. The same applies for the criteria from the Knowledge Management Support level. They will be



Criteria / Tool	Website	Free version	Calendar	Gantt-Chart	Cost Management	Resource Management	Work Breakdown Structure	Task Dependency Manage-	Pert Chart/CPM	Status Tracking	Reporting	Shared Agenda	Chat/Discussion	Desktop Sharing	E-Mail	Audio & Video Conferencing	Generate & Organize Ideas and Comments	Group Writing and Modelling	Work Flow Management	Sum of fulfiled criteria
projectplace	https://www.projectplace.com	trial	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	14
Wrike	https://www.wrike.com	free	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✓	✓	✓	13
iMeet central	https://imeetcentral.com	trial	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	13
active.collab	https://activecollab.com	trial	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗	✗	✗	✓	✗	✓	12
Clarizen	https://www.clarizen.com	trial	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗	✗	✗	✓	✗	✓	12
teamwork projects	https://www.teamwork.com	trial	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗	✗	✗	✓	✓	✗	12
Easy Projects	https://www.easyprojects.net	trial	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗	✓	12
Same-Page eStudio	http://www.same-page.com	trial	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗	✓	11
aceproject	http://www.aceproject.com	free	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	11
Projectmanager.com	https://www.projectmanager.com	trial	✗	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗	✗	10
Project Drive	https://www.project-drive.net	trial	✓	✓	✓	✓	✓	✓	✗	✓	✓	✗	✗	✗	✗	✗	✓	✗	✗	10
Zoho Projects	https://www.zoho.eu/projects/	free	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗	✗	10
Geniusproject	https://www.geniusproject.com	trial	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✗	✓	✓	10
twproject	https://twproject.com	trial	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✗	✗	✗	✓	✗	✗	10
Redbooth	https://redbooth.com	trial	✓	✓	✗	✗	✓	✓	✓	✓	✓	✗	✓	✗	✗	✓	✓	✗	✗	9
Onepoint Projects	https://www.onepoint-projects.com	trial	✗	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	9
Workbook	https://workbook.net	trial	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	✗	✗	✓	✗	✗	9
ProWorkflow	https://www.proworkflow.com	trial	✗	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗	✗	9
Freedcamp	https://freedcamp.com	free	✓	✗	✓	✓	✓	✗	✓	✓	✗	✓	✓	✗	✗	✗	✓	✗	✗	8
Studio Manager	https://goodwerp.com/studio-manager	trial	✓	✗	✓	✓	✓	✓	✗	✓	✗	✓	✓	✗	✗	✗	✓	✗	✗	8
asana	https://asana.com	free	✓	✗	✗	✗	✓	✗	✗	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	7
glip	https://glip.com	free	✓	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗	✗	✓	✓	✗	✗	6
bambam!	http://www.dobambam.com	trial	✗	✗	✗	✓	✗	✗	✗	✓	✗	✓	✓	✗	✗	✗	✓	✗	✗	5
Basecamp	https://basecamp.com	trial	✓	✗	✗	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	✗	✓	✗	✗	5

Table 6-1: List of software tools for tool selection

closer examined as part of the long-term information management capabilities in the following section.

The selection of software tools that best fit the definition of CPMS gives some interesting insight about the applicability of the definition to what is currently offered on the market. The defined Project Management features are mostly present, with the exception of a PERT chart (Program evaluation and review technique) or other forms of the critical path method (CPM). Since this could usually be implemented in combination with the Gantt-Chart, it can be assumed that the feature nowadays is not as relevant for Project Management as Chen et al. (2006) considered it to be. Another interesting insight is the fact that the collaboration features desktop-sharing, E-Mail, audio & video conferencing and group writing and modelling are largely non-existent. It can be assumed that CPMS usually don't serve as the only software platform in a company, but are accompanied by other applications such as Skype for Business or TeamViewer and a stand-alone E-Mail solution or even by full ECS platforms like IBM Connections. Some of the vendors of CPMS, for example Zoho (https://www.zoho.eu/), offer other applications that are available in a bundle and integrate with each other.

The following 7 tools fulfil 12 to 14 of the 17 criteria, thereby coming closest to the definition of Collaborative Project Management Software and therefore they are analysed in the following section:

- Wrike (https://www.wrike.com/) – Enterprise version
- Projectplace (https://www.projectplace.com) – Enterprise version
- iMeet Central (https://imeetcentral.com) – Enterprise version
- active.collab (https://activecollab.com/) – Standard plan
- Clarizen (https://www.clarizen.com/) – Enterprise Edition
- Teamwork projects (https://www.teamwork.com/) – Business version
- Easy Projects (https://www.easyprojects.net/) – Enterprise version

Even though the selection of those tools based on the previously defined criteria is not necessarily the only way in which a subset of tools could have been selected, the selection contains a variety of tools regarding their orientation to company sizes and – most importantly for this study – regarding the types of information they contain that must be managed in the long-term.

6.2 Tool analysis

In the following, each of the 10 software tools selected in the previous section is examined towards its orientation to customer segments, its specific set of features as well as other important aspects, which are briefly outlined. For the analysis, free or trial accounts of the selected 10 software tools were created. The different types of digital business content that exist in the specific tool are listed in the respective tables. Since they usually are compound documents the attached content and the metadata of each type of document is specified. For reasons of simplicity sometimes metadata is aggregated, for example “address” instead of “street, city, postal code, state, country”. The tool’s different functionalities for the long-term management of its specific types of digital business document are described in the third row of each table. Additional functionalities that apply to the content of the tool in general are described below each table.

Wrike

Wrike is advertised as a “Work Management Software” which contains features for all kinds of project teams and particularly for project managers as well as specific functionalities for the collaboration of marketing, creative and product development teams.

It consists of three main building blocks: tasks, folders and projects. Tasks can be assigned to one or multiple folders or projects or stand on their own. Folders can serve as a way of tagging and a way to share tasks with other users more easily. In addition to the metadata described below it is possible to define custom fields for tasks, folders and projects.

It is worth noting that Wrike offers the additional purchase of a “Proofing and Approval” add-in that implements the option to initiate a review process for attached files. This creates new metadata such as the current status of the process (like “pending”, “changes requested” or “approved”), the users assigned to the review and comments made on the document. Because this add-in is not included in the trial version it could not be analysed in more detail.

Type of document	Attached content or metadata	Long-term information management functionalities related to type of document
Task	Title, importance, status, assignees, author, date, duration, time spent, subtasks, attached files, dependencies, shared with, description, comments	XLS Export: exports all metadata of tasks within a project or folder to an Excel document. Attached files and comments are not included.
Comment	Author, date of creation, text, attached files	No specific long-term information management functionality could be identified.

Attached file	Title, author, date, file size, version number	A new version is created every time the file is edited or a manually uploads a new version.
		Attachments can be downloaded individually or all that are associated with one task/folder/project at once.
Folder	Title, subfolders, subprojects, shared with, color, attached files, description, comments	XLS Export (see above): depicts folder structure, but does not export any metadata or attached content.
Project	Title, subfolders, subprojects, shared with, color, project status, attached files, owners, start date, finish date, description, comments	XLS Export (see above): depicts project structure, but does not export any metadata or attached content.

Table 6-2: Findings of the tool analysis for Wrike

Wrike also contains a **search** functionality that allows to search and filter for tasks. It indexes all metadata as well as the content of comments and names of attached files. The content of attached files and the metadata and attached content of folders and projects are not indexed. Folders and projects can be searched for via a separate search form, but only by their names.

The functionality to back up an account can be useful in case of a legal hold: account admins can perform a **backup** that contains all tasks shared with them, including file attachments and comments. A file can also be locked, but only automatically when it is edited by a user, so this feature is of no use to perform e-Discovery.

Wrike contains no functionality for Knowledge Management and Wrike's own blog even gives an alternative suggestion on how to handle **Lessons Learned**: „Set up a knowledge base or an intranet where every team can store their lessons learned and access advice from other teams" (Bonnie 2015). Similarly, there is no specific **archiving** functionality, but Wrike's help portal suggests to create a folder, name it "Archive" and move tasks, folders or projects that should be archived to this folder.

Wrike currently has 38 different **integrations** with other apps or services, none of which are specifically geared towards long-term information management. It is possible to attach files from other locations (Dropbox, Box, Google Drive, OneDrive) which could enable more long-term management capabilities. The Wrike **API** could be used to implement custom solutions that allow the retrieval of the other types of documents.

Projectplace

Projectplace is advertised as a "all-in-one work collaboration tool" with features "beyond a traditional project management software". In addition to Project Management features it allows

advanced document management and real-time collaboration but also provides functionalities specifically geared towards project managers.

Projectplace on the highest level is organised by workspaces which typically represent one project. Workspaces can be aggregated in portfolios to create reports on all projects of the portfolio. Within a workspace there are conversations represented as a news stream, activities and milestones shown in a plan, cards displayed on a board and documents in document library.

Type of document	Attached content or metadata	Long-term information management functionalities related to type of document
Workspace	Title, description, cost code, status	Complete workspaces can be archived which locks all content in them and preserves the current history. This is typically used when a project is finished.
		The option to create templates from existing workspaces that can be used to create new workspaces can serve as a way to preserve knowledge about the management of the project and about contents of the project, because the templates can include all of the content existing in the current workspace.
Conversation	Content, attached files, likes, comments, author, date	All conversations of a workspace can be downloaded. This creates a .zip-file that includes an Excel file listing all conversations and comments and their metadata as well as a folder containing all attached files.
Activity (Milestone)	Title, description, dependencies, duration, start date, end date (in case of milestone only date), estimated time, reported time, associated board, associated cards, comments, history	All activities and milestones on a specific plan can be downloaded. This creates an Excel file listing all activities and milestones, their metadata and the associated comments. In contrast to the functionality for conversations and cards, this does not export the files attached to the comments of activities.
Card	Title, description, assignee, due date, label, status, points, associated activities, checklist items, attached files, estimated time, reported time, comments, history	All cards on a specific board can be downloaded. This creates a .zip-file that includes an Excel file listing all cards, their metadata and the associated comments as well as a folder containing all attached files.
Document	Name, modified by, modified date, created by, created date, file size, description, comments, history, version	A document can be permanently locked which preserves it in its current state. Documents can also be locked temporarily. This feature is typically used when a document is being edited, but can also be used in case of a legal hold.
		Documents can be put under version control which automatically creates a new version every time the document is edited.
		The document's history is shown that not only includes when a document was created or edited and by whom, but also who read a document and when. This functionality can be used as an audit trail.

		A list of a workspace's full document structure can be exported and includes each document's metadata. This can be used to preserve the information in a different system as a record.
		Parts of or all of a workspace's documents can be downloaded, including all versions of each document.
		In the templates for workspaces (see above) a special document folder called "Knowledge base" can be implemented that allows to organize documents in knowledge categories and share them across all projects that are based on the template. Documents from other places in the system can be reused in the knowledge base.
Attached file	Title and file size or link to document	Attached files can exist on conversations, activities, cards or comments and are part of the respective download functionality, except for those attached to activities (see above).
Comment	Content, author, date, attached files, likes	Comments can exist on conversations, activities or cards and are part of the respective download functionality (see above).

Table 6-3: Findings of the tool analysis for Projectplace

While Projectplace includes a **search** functionality that can help the user to find and filter the abovementioned types of content, it does only index activities, cards and documents. It is possible to **integrate** other file storage solutions to store the documents in and to use the comprehensive **API** that allows to connect and interact with all types of content in the to connect to a federated search engine.

iMeet Central

Even though iMeet Central contains most features that would qualify it as a full Enterprise Collaboration Software, such as workspaces, advanced file management and collaboration or real-time audio and video communication, it also has sufficient Project Management capabilities. This is also represented by its description as a "single place for all your work".

Similar to Projectplace, iMeet Central is primarily structured via workspaces. These are assigned to a customer account and contain different tabs for different functionalities. A contact directory provides information about project members and stakeholders and allows to manage their permissions in the workspace. The wiki tab allows the users to create wiki pages that can be organized in a wiki structure. They can also be converted to so-called online documents that are managed in the files & discussions tab with the help of folders and tags. This tab can also contain discussions, files and link items. Discussions can also be converted into online docu-

ments. The Project Management tab contains tasks that can be organized in task lists and milestones that can be associated to task lists. Files can also be attached to tasks and milestones, but then do not have all the same functionalities as files that are uploaded into the files & discussions tab. Time tracking records are held separately from tasks, but there also is a functionality to log time on tasks. Lastly, the database tab allows to create customized tables for different purposes such as ticketing or asset tracking.

Type of document	Attached content or metadata	Long-term information management functionalities related to type of document
Workspace	Title, description, start date, end date, created date, custom fields	Complete workspaces can be archived which makes them read-only. Alternatively, a backup can be created for use outside of the system.
		An audit log report can be created that lists all activities performed in a workspace over a specifiable period of time.
		The advanced project (workspace) search utilizes the custom fields and can be used in eDiscovery cases or to support Knowledge Management by making it easier to find projects related to certain topics.
Person	Full name, department, title, e-Mail, phone	The list of contacts can be exported to a .csv-file that contains all contact information.
Task, Milestone	Title, priority, status, assignees, followers, start date, due date, created by, created date, last modified by, last modified date, description, associated task list, attached files, related online documents/discussions/files/links, budgeted time, dependencies, tags, reminders, logged time, comments	Milestones and tasks on a task list can be archived manually or automatically after completion. From the archive they can be viewed and un-archived.
		Milestones and tasks on a task list can be exported to a .csv-file either individually or all together as an export of the whole project.
		Existing task lists can be converted to a template in order to reuse them in future projects.
		An audit log is created that tracks all activities on the item for the last 90 days including activities on the associated comments and it can be downloaded as a .csv-file.
Database record	Depending on the purpose of the database different fields with different field types can be created.	The database as a whole or filtered by view can be exported to .csv-file. Attached or related files, tasks or milestones cannot be exported together with the database records.
Online Document, Wiki page, Discussion,	All: Title, content, last edited by, last edited date, tags, likes, comments Only online document and discussion: Status, related tasks & milestones	An audit log is created that tracks all activities on the item for the last 90 days including activities on the associated comments and it can be downloaded as a .csv-file.
		The version history is automatically tracked and older versions of files can be rolled back.
		Files can be downloaded in bulk and online documents, wiki pages, discussions and links can be saved as a .pdf-file.

Link, File		All items (wiki pages first have to be converted to online documents) can be archived. This removes them from their current folder and places them in the archive.
		Items in the archive are not automatically locked. A permanent lock can be achieved by assigning the status "Final [READONLY]".
		Folders containing the items in the files & discussions tab can be shared with other workspaces. This makes it possible to automatically provide certain documents for new project workspaces.
Comment	Author, content, created date, subscribers, attached files, related online documents/discussions/files/links	The content of comments is not part of the .csv-file export functionality of the abovementioned types of document that a comment can be related to.
		Comments are extracted together with the abovementioned types of document that it is related to when the respective archiving functionality is used and activities on the comments are tracked in the respective audit logs.
Attached file	Title, size, created by, created date	Files that are directly attached to tasks, milestones or comments cannot be exported with the respective export functionality, but are archived with the item they are attached to. It is encouraged to use the functionality of relating files from the files & discussions tab instead of attaching files directly.

Table 6-4: Findings of the tool analysis for iMeet Central

Besides the abovementioned advanced project (workspace) **search** there is the option to perform a simple search or an advanced search which allows the use of different criteria and filters and indexes any content within the system. Archived workspaces are not searched by standard, but can be included in the advanced search.

The **workflow engine** can be used for Records Management purposes, for example by implementing an automatic retention schedule based on criteria like the document type, tags, etc. that moves to the archive or a special folder and locks them by changing their status.

active.collab

Active.collab supports the Collaborative Management of Projects with a number of functionalities for cost and resource management, including a separate time tracking application. Likewise, the support for the Management of Collaborative Projects is provided by team collaboration features. It is advertised for different types of project teams, including marketing, design, software development and more.

The tool is centred around projects that include tasks which can be organized in task lists. Projects also provide functionalities for a discussion forum, note-taking and time and expense recording. All files attached to other elements as well as separately uploaded files are listed in a simple list for each project.

Type of document	Attached content or metadata	Long-term information management functionalities related to type of document
Project	Name, description, label, category, client company	No specific long-term information management functionality could be identified.
Task	Name, description, attached file, subscribers, task list, assignee, due date, labels, priority, subtasks, time logs, expenses, reminder, comments	A history of changes shows the changes to the task itself, but not to attached comments or files.
Task list	Name, start date, end date	No specific long-term information management functionality could be identified.
Discussion	Name, description, attached files, started by, started date, comments	A history of changes shows the changes to the discussion itself, but not to attached comments or files.
		The discussion can be moved or copied to another project.
Note	Name, description, attached files, started by, started date, comments	A history of changes shows the changes to the note itself, but not to attached comments or files.
		The note can be moved or copied to another project.
		Every time a note is edited a new version is created and old versions can be viewed and changes are highlighted.
Time record	Time, description, user, job type, date, task, billable	No specific long-term information management functionality could be identified.
Expense	Amount, description, user, job type, date, task, billable	No specific long-term information management functionality could be identified.
Comment	Author, created date, content, attached file	No specific long-term information management functionality could be identified.
(Attached) file	Name, uploaded by, uploaded date, size	No specific long-term information management functionality could be identified.

Table 6-5: Findings of the tool analysis for active.collab

Project **templates** can be used to prepopulate a project with tasks and task lists, discussions, files and notes in order to disseminate general knowledge among future projects. A template cannot be created from an existing project.

Reports on the progress of project, its budget, etc. can be created and exported, but do not contain any of social content such as the comments or any files.

The **search** functionality is also very basic and cannot retrieve results from comments or files. It is possible to connect Google Drive and Dropbox as alternative file storage location which could provide more long-term information management options.

Clarizen

In contrast to most of the other CPMS in this study, Clarizen is mainly geared towards teams in larger enterprises, by offering a broader set of integration and security options. This orientation also is reflected in the fact that it is the only selected CPMS that is part of the Gartner Magic Quadrant for Cloud-Based IT Project and Portfolio Management Services (Stang et al. 2016a). It provides a lot of functionalities project managers such as portfolio management and reporting. The pricing model also differentiates between different licences for project managers and team members. Nevertheless, Clarizen also supports collaboration features which is why it qualifies as a CPMS, unlike most of the other applications in the Gartner Magic Quadrant.

Clarizen is not as strictly centred around projects or workspaces as other CPMS are, but rather just provides different items that can be related to each other in almost all ways, including parent-child relations. The so-called discussion feature allows to create a discussion topic and posts related to it and is available globally as well as in combination with all work items and cases as a kind of comment feature.

Type of document	Attached content or metadata	Long-term information management functionalities related to type of document
Discussion	Name, author, related tasks, related documents, topics, likes, posts, created date	Discussions and discussion groups can be created to discuss and distribute knowledge and can be related to work items, topics, files, etc.
Work item (Project, Milestone, Task)	Name, status, state, due date, % complete, owner, topics, actual effort, remaining effort, expected progress, start date, work time, duration, constraint type, work policy, created by, created date, last updated by, last updated date, related documents, resources, followers, discussion, child work item	Lists of work items can be exported to a .csv-file that contains three to five of the metadata fields (depending on the type of work item), but none of the attached social contents are included.
		Projects including tasks and milestones can be exported as a project plan for MS Project.
		Templates can be created from existing projects or milestones which allows the re-use of knowledge gained during a project.
Case (Bug, Issue, Risk, Request)	Name, description, severity, priority, mandatory, owner, due date, assignee, created by, created date, reported by, reported date, last updated by, last updated date, project, category, customer, followers, discussion	Lists of cases can be exported to a .csv-file that contains three to five of the metadata fields (depending on the type of case), but none of the attached social contents are included.

Post	Content, author, likes, label, topics, created date	No specific long-term information management functionality could be identified.
File	Name, document type, storage type, topics, created by, created date, last updated by, last updated date, discussions, related items	No specific long-term information management functionality could be identified.

Table 6-6: Findings of the tool analysis for Clarizen

Clarizen stands out due to its high customizability that allows to implement more universal long-term information management functionalities. **Reports** can be customized to aggregate and extract any kind of data based on the generic relations feature. For example, it is possible to create a report containing all work items and cases related to a project or a topic, including their discussions and posts and even the likes associated to these. The report can then be exported to a .xls- or .pdf-file and even be scheduled to run regularly. This feature can not only be used for general Records Management purposes, but also in eDiscovery cases.

Another option for customization are the so-called **applications** that can be purchased from the app marketplace and that integrate additional functionalities into the system. The “Move to Archive” application is freely available and creates an archive project in which all types of items can be moved via a button. The “Document Publisher” application is also free and increases the customizability for the abovementioned reports, by exporting them based on user-definable templates in Microsoft Office or PDF formats. The “Data Warehouse Export” application is a powerful tool that allows the scheduled export of the data in Clarizen to data warehouse applications, such as Amazon Redshift or Box. This is a useful tool for companies that already have systems for company-wide information management in place. With a price of 1000$ per month this application is intended for bigger corporations.

Another way to export the data to ECM systems is the **integration** with Google apps or SharePoint which allows to attach files from these systems or upload files that are attached to items in Clarizen to these systems. Since these systems provide more distinctive long-term information management functionalities for documents, this can be a way for smaller companies that have these systems in use instead of a full data warehouse.

Teamwork projects

Teamwork projects is Collaborative Project Management Software with no explicit orientation towards a special customer segment. In addition to the common Project Management and Collaboration features it also allows time tracking with a desktop application and comparably advanced file management features. While there is an enterprise version available which includes

increased security, support and availability, it is not available as a free or trial version which is why the “business” version is analysed in this study.

The tool is centred around projects which contain different tabs for different functionalities. Tasks can be organized in task lists and associated to milestones. The messages tab serves as a discussion board for project team members and a notebook can be created to record project information or meeting notes. The files tab lists all files that have been uploaded as attachments to other items or in the tab itself under different categories that work like folders. Outside of projects the users can post status updates.

Type of document	Attached content or metadata	Long-term information management functionalities related to type of document
Project	Name, description, category, tags, status, start date, end date	Name, customer and description of a project are included in the task report (see below).
		A list of all projects and their metadata can be exported to .pdf, .xls and .csv-files.
		A project can be archived which makes it read-only.
Task	Name, assignee, start date, due date, description, attached files, priority, progress, estimated time, dependencies, reminders, tags, created date, created by, edited date, edited by, time logs	An activity log is kept that shows all changes to the task. Viewing activity is not included.
		A single task can be exported to a .pdf-file that contains the task’s content, including comments and the activity log. Files attached to the comments are indicated, including their metadata, but no link is provided.
		Tasks from a particular project can be exported via a task list report that can be saved as a .pdf-file. This includes the comments on tasks and time logs, but not files attached to the comments.
Task list	Name, note, milestone	Tasks from one or multiple task lists can be exported via task list repot (see above).
Milestone	Name, due date, responsible, description, followers, tags, comments	An activity log is kept that shows all changes to the milestone. Viewing activity is not included.
		A single milestone can be exported to a .pdf-file that contains the milestone’s content, including comments and the activity log. Files attached to the comments are not indicated.
		Milestones from a particular project can be exported to a .xls-file. This does not include the comments or files attached to the comments.
		All (or filtered) milestones can be exported to a .pdf-file. This does not include the comments or files attached to the comments.

Message, reply	Title (only message), tags (only message) author, created date, content, attached files, tags, likes, notified users	A single message can be downloaded as a .pdf-file. This includes the attached comments and indicates the number of attachments of a comment.
		Messages can be archived which removes them from the "All Messages" folder and the category folders and places them in an "Archived Messages" folder.
File	Name, uploaded by, uploaded at, size, version, category, tags, comments, likes,	It is possible to upload new versions of a file. Old versions can be retrieved.
		Files can be locked so that only the user who locked it can still edit it.
Time log	Time spent, start time, end time, billable, billed, description, date, user, tags	A list of all time logs from a project can be exported to .pdf, .xls and .csv-files.
Notebook	Title, description, content, category, version, created by, created date, tags, comments, follower	Every time a notebook is edited a new version is created. Old versions can be retrieved and compared with the current version.
		A notebook can be locked for editing so that only the user who locked it can still edit it.
		Notebooks can be viewed in a printable version that includes their metadata and comments, but not the likes and attached files on the comments.
Risk	Risk source, probability, impact, impact areas, status, mitigation/response plan, created by, created date, updated by, updated date	A list of all risks in a project can be exported to an .xls or .pdf-file.
Link	Title, URL, description, tags, category, comments, created by, created date, updated by, updated date	A list of all links in a project can be exported to an .xls-file which does not include the comments associated with the links.
Comments	Author, created at, content, attached files, likes, notified users	Comments are sometimes exported with the export functionalities of the documents they are related to (see above). There is no specific functionality to export comments.
Status	Author, content, created date	The status updates can be retrieved with an RSS feed, which could be used to automatically record them for Records Management purposes.

Table 6-7: Findings of the tool analysis for Teamwork projects

An **activity report** can be generated as a .pdf-file that lists all creations, edits and uploads of items or documents over a customizable period in all projects of the tenant. A **backup** of the entire database of a Teamwork projects tenant can be created as a MySQL file in case it needs to be searched, for example in an eDiscovery case.

The **integrations** feature allows to connect ECM systems like Box.com and others as an alternative storage location for files. This allows to leverage the long-term information management functionalities that might already be in place in these systems. Additionally, the extensive **API** provides the opportunity to connect the other types of documents to systems that enable the long-term management. It can also be used to make all content searchable. The built-in **search** can be customised to include the different types of documents, including comments and attached files, but it does not index the content of the files.

Easy projects

Easy projects is advertised as a tool for freelancers as well as large businesses that need an "enterprise project collaboration platform". The wide range of features supports different kinds of teams "in a wide array of industries". In addition to the cloud-version examined in this study, it is also available as an on-premises solution.

Easy projects is centred around projects that can contain different kinds of activities and can be assigned to a customer and a portfolio. Time logs, messages and files are attached to activities which are mainly displayed in work breakdown structure that can be filtered based on the different fields.

Type of document	Attached content or metadata	Long-term information management functionalities related to type of document
Project	Title, priority, status, start date, end date, duration, customer, managers	All projects that are displayed based on how the filters are set can be exported into a .csv-file that contains their metadata, but not their messages or attached files.
		An audit trail is maintained that shows all changes to the project.
Activity (Task, Issue, Request)	Title, priority, category, description, status, start date, end date, duration, dependencies, assignees, estimated hours, hours left, budget, messages, files, created date, created by, percent done, parent activity, time log	All activities that are displayed based on how the filters are set can be exported into a .csv-file that contains their metadata, but not their messages or attached files.
		An audit trail is maintained that shows all changes to the project.
Customer	Company name, address, contact details, billing hourly rate, description	The customer details page can be viewed in a printer friendly version and thereby saved as a .pdf-file.
Portfolio	Name, category, status, description,	No specific long-term information management functionality could be identified.
Time log	Person, hours, project, activity, date, description, billable	No specific long-term information management functionality could be identified.

Message	Author, created date, content, attached file	No specific long-term information management functionality could be identified.
Attached file	Name	No specific long-term information management functionality could be identified.

Table 6-8: Findings of the tool analysis for easy projects

Reports that display the different types of document can be created and exported as .xls .pdf-files, but like the abovementioned export functionality do not include messages or files. The same holds true for the **search** functionality that only indexes the name and description of the different types of documents. Easy projects also offers an API that allows the connection to other systems for long-term information management purposes.

7 Classification and Evaluation of the Status Quo

The analysis of the software tools in chapter 6 gives an in-depth view into the different types of digital business documents that exist in CPMS that are currently on the market and into the functionalities the CPMS contain which enable the long-term management of these digital business documents. The analysis has shown some recurring patterns, for example that most tools have a project or workspace as the first level of structure that then contains one or multiple kinds of task items which usually have comments and files attached to them. These items, together with some form of discussion forum and wikis, are the most common occurrences of social business documents in CPMS and must be manageable beyond the duration of the respective project as is shown in chapter 4. Most tools also provide some implementation of the PMBoK information flow which is described in section 3.1 in the form of reports that aggregate the work performance data. In some instances, these reports can be exported for means of long-term storage.

In the following the long-term information management capabilities of CPMS are aggregated by classifying them based on how well the functionalities identified in the previous chapter cover the requirements that are identified in chapter 5. Table 7-1 shows if and how each of the requirements (see Table 5-1) is met by the respective software tool.

Requirement #	Wrike	Projectplace	iMeet Central	active.collab	Clarizen	Teamwork projects	Easy Projects
1.1	only files	only documents	only documents, wiki, etc.	none	none	only files and notebook	none
1.2	sufficient	sufficient	sufficient	sufficient	sufficient	sufficient	sufficient
1.3	custom fields, tags (folders)	no capability for custom metadata	custom fields, tags	only categories for projects and teams	topics, custom fields	tags, categories	categories, custom fields
2.1	export only without attached content	export including attached comments and files	export only without attached content	no export of documents	attached content partially part of reports, data warehouse export	attached comments partially included in export, files not	export only without attached content
2.2	no sufficient archiving functionality, full backup can be created	export of documents and some metadata into RM system possible	use of archiving functionality in combination with workflow engine	no RM capability	export of documents and metadata into RM system possible via data warehouse export	export of documents and some metadata into RM system possible	export of documents and some metadata into RM system possible
2.3	no audit trail available	audit trail only for documents	audit logs of all relevant content	history of changes shows some activities	audit trail for all documents possible via integration with other system	activity log shows some activities	audit trail partially available

Requirement #	Wrike	Projectplace	iMeet Central	active.collab	Clarizen	Teamwork projects	Easy Projects
3.1	no KM capability	knowledge base functionality	creation of wiki pages, advanced search for topics, sharing of items across workspaces	notes feature for projects	use of discussion groups to distribute knowledge about certain topics	notebook feature can be used to capture knowledge during project and later export	no KM capability
3.2	no capability for re-use	workspace templates created from existing workspaces	use of existing task-lists to create templates	no capability for re-use	use of existing projects or milestones to create template, relating work items, files, etc. to discussions	no capability for re-use	no capability for re-use
4.1	not all relevant content indexed by built-in search	not all relevant content indexed by built-in search	all relevant content indexed by built-in search	not all relevant content indexed by built-in search	use of data warehouse export to make all relevant content searchable	content of attached files not indexed.	not all relevant content indexed by built-in search
4.2	integration of file storage that can connect to federated search use of API to make social content accessible	integration of file storage that can connect to federated search use of API to make social content accessible	integration of file storage that can connect to federated search use of API to make social content accessible	integration of file storage that can connect to federated search	integration of file storage that can connect to federated search use of API to make social content accessible	integration of file storage that can connect to federated search use of API to make social content accessible	use of API to make social content accessible
4.3	no functionality to preserve content in its current state inside the system	whole workspaces or single documents can be locked	whole workspaces, single tasks/milestones or documents can be locked	no functionality to preserve content in its current state inside the system	no functionality to preserve content in its current state inside the system	whole projects, single files or notebooks can be locked	no functionality to preserve content in its current state inside the system

sufficiently fulfilled | partially fulfilled | fulfilled with help of other system | not sufficiently fulfilled

Table 7-1: Requirements for long-term information management met by CPMS

Table 7-1 shows a few different patterns that become apparent when comparing the current functionalities of CPMS with requirements from different areas of long-term information management. First of all, a distinction has to be made between requirements that are fulfilled within the system and requirements that can only be fulfilled in combination with another system. Requirement 4.2 (Possibility to connect federated search engine) is a good example for this as there either is the possibility to use the API of the tool itself or to use another system for the storage of files which possesses the capability to connect to a federated search engine.

This example shows another important pattern which is that the long-term management of files in CPMS is much more developed than that of social content. Versioning as well as the possibility to maintain a sufficient audit trail are either not possible or only for files, with the exception being Projectplace that offers an audit log for all types of documents. iMeet Central is the only tool that allows the automatic declaration of any kind of document as a record (requirement # 2.2) and the keeping of a sufficient audit trail (# 2.3) within the system with the help of its workflow engine. Most other systems have no Records Management capabilities or are not sufficiently able to extract all social business documents. The notion that comments by themselves are a social business document, but only are of value when managed together with the content they comment on (Hausmann & Williams 2016), is reflected by the fact that in almost all cases in which comments can be exported it is only possible by exporting the item they are related to. However, this notion also implies that items that can be commented on are also social business documents and thus need to be managed together with the comment. Projectplace is the only tool that allows sufficient functionality to extract these compound documents (# 2.1) manually and only Clarizen with its ability to export to a data warehouse is capable of doing this in an automated way.

Capabilities for the automated management of file records on the other hand are much more developed. Except for easy projects, all tools allow the integration of a file storage solution such as Box.com, Dropbox, Google Drive or OneDrive. These naturally have stronger information management capabilities, but mostly are not equipped to handle social business documents from a CPMS (Basso et al. 2016). Thus, ideally CPMS would be able to connect to an ECM solution that acts as a uniform content warehouse (data and document warehouse) for all types of information as it is described by Kampffmeyer (2006). Of all the examined tools, only Clarizen offers this functionality via an add-in and without the need to create a custom solution with the help of the API.

Overall, when it comes to meeting conformance requirements iMeet Central and Clarizen have the most capabilities. This coincides with these tools' orientation towards larger enterprise customers that often have higher regulatory and governance demands. In contrast to that, Wrike's, active.collab's and easy projects' conformance capabilities consist mostly of export functionalities that do not include all social content related to the items and of insufficient audit trail and e-Discovery functionalities. This may be sufficient for smaller companies that rarely encounter compliance obligations which also is reflected in the orientation of the marketing of these tools. Projectplace and Teamwork projects are somewhere in the middle of this spectrum by partially fulfilling most of the Records Management requirements and allowing the legal hold of all relevant content within the system (# 4.3).

Performance objectives show a similar picture with iMeet Central, Clarizen and Projectplace as the only tools that allow the creation and automatic distribution of knowledge artefacts across all projects (# 3.1). Teamwork projects and active.collab contain functionalities to capture knowledge and distribute it manually if needed and Wrike and easy projects have no specific Knowledge Management capabilities. The template functionality proved as the only straightforward way to re-use knowledge that was gained during a project, such as tasks or project plans, in future projects (# 3.2) and it also is only part of iMeet Central, Clarizen and Projectplace. Interestingly, none of the tools provide a functionality explicitly for Lessons Learned, even though it is a standard process in Project Management (see section 4.3). However, the templates can support many of the activities that are defined in the first two process groups (initiating and planning) of the PMBoK, such as develop project charter, create work breakdown structure, define activities, estimate activity resources and durations or develop schedule (see section 3.1).

Although all of the analysed tools contain a search functionality, only that in iMeet Central is by itself able to fully support the performance related objectives of information retrieval by indexing all relevant content in the system, including the content of attached files (# 4.1). Teamwork projects only misses this kind of content and all other tools are not capable to index all relevant content, especially social content in comments or discussions. Therefore, the abovementioned ability to connect to a federated search engine (# 4.2) is not only relevant to e-Discovery, but also for general Enterprise Search scenarios in which users want to find specific information about projects that has not been captured in knowledge artefacts.

The requirements related to the performance objectives of long-term information management are again mainly met by the systems that are geared towards larger companies; possibly because these have a higher demand to capture and make knowledge available in a more systematic way than smaller companies in which person-to-person communication can often be sufficient to get the right information.

In general, the analysis of the 7 different CPMS tools has shown that, while many different functionalities which support some sort of long-term management of the tool's content exist, only enterprise-grade tools have sufficient capabilities that allow the implementation of a comprehensive Enterprise Information Management strategy for all types of digital business documents.

8 Summary and Future Work

Several research steps are conducted in this thesis; mainly the review of literature relevant to the topic, the selection and analysis of software tools and the assessment of the status quo in regard to how the analysed tools meet the requirements identified in the literature research. The findings of each of these research steps are summarised in the following section (8.1).

There have been multiple limitations to this study and the results of the research have given some indications on what topics could be investigated more closely. Thus, section 8.2 gives an overview of future research tasks that could advance the understanding of long-term information in Collaborative Project Management Software.

8.1 Summary of the Findings

The aim of this study is to examine how well the long-term information management needs and requirements are currently met by Collaborative Project Management Software and which challenges for the implementation of an Enterprise Information Management strategy might exist. The initially developed 7 research questions for achieving this aim are answered in the course of this study and the findings are summarised in the following.

RQ1a) and b) address what the requirements and needs for the long-term management of information that generally apply in an enterprise context and that are particularly relevant in the context of Project Management are. Within these requirements, a distinction is made between conformance and performance objectives and in addition to the general area of EIM three specific fields of long-term information management are identified. While Records Management mainly aims to meet conformance objectives, Knowledge Management is about increasing the performance of a business. The requirements from the field of Records Management all apply in a general enterprise context and no specific project related requirements are found. In contrast, Knowledge Management is of particular importance in a project context, because knowledge is often isolated within one project and not managed beyond the project's lifespan. The third field, Information Retrieval, imposes requirements that meet conformance objectives in the form of e-Discovery as well as performance objectives in the form of Enterprise Search.

RQ2a) is which software tools are available that support Collaborative Project Management? Based on the literature research on the aspects of Project Management, Enterprise Collaboration and the associated types of software it is ascertained that Collaborative Project Management Software is a type of software that combines functionalities from traditional Project Man-

agement Information Systems and Enterprise Collaboration Systems and enables the Collaborative Management of Projects as well as the Management of Collaborative Projects. Available software tools are researched and a selection of 7 tools that are viable for in-depth analysis and represent the abovementioned description of CPMS is identified.

RQ2b) What are the different types of content that exist in these tools? is answered in the tool analysis which identifies some recurring patterns for the different types of digital business documents. Because of the collaborative nature and as expected as part of the motivation for this study, most documents in CPMS can be classified as social business documents. Recurring building blocks are projects or workspaces that include tasks or activities that have descriptive metadata as well as attached contents which mainly are comments or discussions and files.

RQ2c) asks what are the long-term information management functionalities for the different types of content of these tools? These are also identified in the tool analysis. It appears that the type of long-term information management functionality is mostly dependent on the type of content it addresses and that there are only few functionalities that apply to all types of content in a system. Common functionalities are the manual export of single items or lists of items to .csv, .xls or .pdf-files, version histories and audit trails, templates and the integration of file storage solutions. Search functionalities exist in all tools, but in vastly varying forms.

RQ3a) and b) address how the long-term information management needs and requirements are currently met by CPMS, which capabilities CPMS currently lack and what challenges for the implementation of an Enterprise Information Management strategy arise because of it. Therefor the previously defined requirements are compared to the functionalities of the tools and common patterns as well as notable special cases are described. One of the findings is that a distinction must be made between the fulfilment of requirements within the boundaries of the system and with the help of other systems by integration or use of an API. Only iMeet Central has sufficient internal conformance capabilities, but companies that have an Enterprise Information Management strategy in place should use an ECM system that covers these requirements and can integrate the data from a CPMS. For file storage, most tools provide standardized integrations that allow the connection of ECM systems, but to effectively manage social content only Clarizen offers a standardized connection and all other tools rely on a custom API connection to provide sufficient conformance capabilities. Similarly, performance objectives are also mainly met by enterprise-grade CPMS and even these only partially take social content into account. Thus, the findings by Hausmann and Williams (2016) that the long-term management of social business documents still faces a number of issues are confirmed for Collaborative Project Management Software and these issues need to be addressed by vendors in order to enable the implementation of comprehensive Enterprise Information Management strategies.

8.2 Future Work

The answers to the research question outlined above provide a general overview of the status quo of long-term information management in CPMS. The limitations of this study as well as its findings encourage multiple directions of further research on the topic.

One major limitation of this study is that it is solely based on literature research and analysis of software tools in an isolated environment and thus does not allow any assertions on how CPMS are used in practice. The findings suggest that those CPMS used by larger companies can be implemented in a firm's general Enterprise Information Management efforts. Whether this actually is the case still has to be determined through research that examines real cases and surveys a representable number of companies.

The tool research examined always the highest-tier version or edition of the software in order to capture the full range of functionalities. Especially smaller companies might opt for lower-tier pricing models which might reduce the long-term management capabilities available to them even more. Thus, a more differentiated research on the requirements and capabilities of long-term information management in CPMS in relation to company size could provide additional insight. Since this study also focussed on tools that are not targeted towards a specific industry, industry specific requirements and capabilities could be another direction for more differentiated research.

New developments in the field of EIM will have an influence on possible research objectives in the context of CPMS as well. For example, topics like Big Data and Business Intelligence have a long-term information management aspect to them that could impose new requirements, especially in relation to performance objectives.

In the future, it will be interesting to see how quickly the boundaries between PMIS, CPMS and ECS continue to blur. Stang et al. (2016a; 2016b) propose in the latest Gartner Magic Quadrants for hosted and cloud-based IT Project and Portfolio Management Services that the demand for collaboration capabilities for these types of software will grow. Especially web-based Project Management Software is often already expected to have collaboration functionalities (O'Loughlin 2016). At the same time with the increasing importance of project-based work, Project Management functionalities could become a increasingly common feature in ECS, leading to a stronger convergence of the software tools on the spectrum as it is described in Figure 3-5.

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