Moving towards integrated digital project management

The transition to a new integrated digital project management system in a construction consultancy company

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Preface

This report serves as the deliverable of the Master Thesis Research. This report represents the end result of the master's program in Construction Management & Engineering at the TU Delft. Throughout the composition of this master's thesis, I had a lot of strong support from many people.

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Kim Baars
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Executive summary

Empirical studies indicate an increasing inclination towards the adoption of integrated software systems that contribute to project management. To this moment, studies on the implementation of these integrated software systems tended to emphasise the benefit of such software. However, the analytical evidence to support such assumptions is relatively small. Therefore, the aim of this research is to investigate and analyse what is required to get the benefits when transitioning to an integrated software system to support project management in a construction consultancy company. As a result, the following research question has been formulated: *"What is required when making the transition to an integrated digital project management system in a construction consultancy company?"*.

For the design of this research the framework developed by Purup and Petersen (2020) was used. The construction of this framework was based on the methodology of action research. The research was divided into three loops. Loop 1 identified the current knowledge regarding a fragmented or integrated system. Loop 2 investigated the use of the integrated system. Finally, in loop 3, all knowledge obtained from loop 1 and 2 was synthesised and developed into an answer to the research question. To answer the research question, a literature review and a case study for which semi-structured interviews were conducted among project managers, project leaders and experts on the implemented system.

A limitation of this study is that the interviews were conducted among users of the system with an age between 24 and 35 years. As a result, no statement can be made on the relationship between age and acceptance or motivation towards transitioning to a new integrated project management system. Therefore, the recommendation is to conduct the interviews in a follow-up study among users of the integrated system whose age distribution is more distributed.

The research revealed that transitioning to an integrated project management system affects the people, organisation, and process within a company. The users of the new system need to embrace the new system and learn to work with it. The transition phase requires a time investment before the benefits will be felt. In addition, an integrated system requires a standardised structure. With this standardisation, certain activities can be automated. This results in saving time. It can therefore be concluded that transitioning to an integrated project management system, after time has been invested for the transition phase, improves work efficiency and can save time.

This research can contribute to the organisations considering implementing an integrated digital project management system. Since more understanding has been generated on what to expect and what actions should be carried out to obtain the benefits of an integrated project management system.

Samenvatting

Onderzoek toont aan dat er een groeiende belangstelling is voor het implementeren van geïntegreerde softwaresystemen die bijdragen aan projectmanagement. Studies naar de implementatie van deze geïntegreerde softwaresystemen hebben tot nu toe de voordelen van dergelijke software benadrukt. Er is echter relatief weinig analytisch bewijs om dergelijke aannames te ondersteunen. Het doel van dit onderzoek is om deze hiaten in de literatuur op te vullen. Daarom is dit onderzoek gericht op het onderzoeken en analyseren van wat er nodig is om de voordelen te verkrijgen bij de overgang naar een geïntegreerd softwaresysteem ter ondersteuning van projectmanagement in een bouwadviesbureau. Als gevolg hiervan is de volgende onderzoeksvraag geformuleerd: *"Wat is er vereist bij de transitie naar een geïntegreerd digitaal projectmanagementsysteem in een bouwkundig adviesbureau?"*.

Voor de opzet van dit onderzoek is gebruik gemaakt van het model dat is ontwikkeld door Purup and Petersen (2020). De constructie van dit model is gebaseerd op de methodologie van actieonderzoek. Het onderzoek is verdeeld in drie fasen. Fase 1 identificeerde de huidige kennis omtrend een gefragmenteerd of geintegreerd systeem. Fase 2 onderzocht het gebruik van het geintegreerde systeem. Als laatste werd in fase 3 alle kennis verkregen uit fase 1 en 2 samengevat en ontwikkeld tot een antwoord op de onderzoeksvraag. Om antwoord te kunnen geven op de onderzoeksvraag is er een literatuur onderzoek gedaan en een case studie waarvoor semigestructureerde interviews zijn afgenomen onder project managers, project leiders en experts op het gebied van de geimplenteerde systeem.

Een beperking van deze studie is dat de interviews zijn afgenomen onder gebruikers van het systeem met een leeftijd tussen de 24 en 35 jaar. Hierdoor kan er geen uitspraak worden gedaan over de relatie tussen leeftijd en acceptatie of motivatie tegenover te transitie naar een nieuw geïntegreerd projectmanagementsysteem. Het advies is daarom dan ook om in een vervolg studie de interviews af te nemen bij gebruikers van het geintegreerde systeem waarvan de leeftijdsverdeling meer verspreidt is.

Uit het onderzoek is gebleken dat de transition naar een geintegreerd project management systeem invloed heeft op de mensen, de organisatie en het proces binnen een bedrijf. De gebruikers van het nieuwe systeem moeten deze accepteren en er mee leren werken. De transitie fase vraagt om een tijdsinvestering voordat de voordelen hiervan merkbaar zullen zijn. Een geintegreerd systeem vereist een gestandardiseerde structuur. Door deze standardisatie kunnen sommige werkzaamheden geautomatiseerd worden. Dit leidt tot tijdsbesparing. Daarom kan er geconcludeerd worden dat de transition naar een geintegreerd project management systeem, nadat er tijd is geinvesteerd voor de transitie fase, de werk efficientie verbeterd en dat er tijd bespaard kan worden.

Dit onderzoek kan een bijdrage leveren aan de organisaties die overwegen om een geïntegreerd digitaal projectmanagementsysteem te implementeren. Aangezien er meer inzicht is gegenereerd in wat er verwacht kan worden en welke acties uitgevoerd dienen te worden om de voordelen van een geintegreerd project management systeem te verkrijgen.

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Nomenclature

Abbreviations

Abbreviation	Definition
ADF	Automated Document Factory
AEC	Architecture, Engineering, and Construction
AECO	Architecture, Engineering, Construction, and Operation
BIM	Building Information Modelling
CDE	Common Data Environment
CSF(s)	Critical Success Factor(s)
DWH	Data Warehouse
ERP	Enterprise Resource Planning
ETL	Extract Transform Load
ICT	Information and Communication Technology
MS	Microsoft
PDF	Portable Document Format
PDM	Project Digital Management
PP	Procurement Plan
PPL	Project Participants List
SaaS	Software as a Service
SL	Spatial Localisation
TC	Time Classification

1

Introduction

Despite the potential of new technologies, particularly digital technologies, the usage of digital technologies in the construction industry is less prevalent than in other industries and is slow to accept new materials, processes, and technology (Barbosa et al., 2017). For the companies to stay competitive in the current Architecture, Engineering, and Construction (AEC) sector they must become more skilled at organisational change management. Failure to embrace change will prevent a company from realizing the full potential of the technology solutions. (Maali et al., 2020).

Digital technologies are comprehensive information and communication systems that facilitate the collection, storing, processing, sharing, displaying, integrating, and collaboration of information (Hamelink et al., 1997). Building Information Modelling (BIM) is the most widely adopted digital technology in the construction industry (Chen et al., 2022). BIM is a coordinated database of integrated information to which many project participants contribute. Continuous and instant analysis of the scope, schedule, cost information and other issues is enabled by using BIM (Rosenberg, 2007). This corresponds to the integrated system investigated in this study. Therefore, the study considers previous studies related to the implementation of BIM.

The adoption and implementation of BIM faces challenges like data sharing issues, integration inefficiencies, a lack of collaborative design, construction, operation, facility management, and communication barriers throughout the project life cycle. Another key concern in the adoption of BIM is the data transfer from one system to another. Loss of data during the course of a project is often expected to reduce the amount of information exchanged. To avoid this, data should be exchanged whenever possible through systems that work together in an integrated and interoperable way (Ozturk, 2020). Data interoperability is frequently highlighted as an important barrier to the adoption of BIM (Shehzad et al., 2021). When employing various systems that should communicate with one another, interoperability can be an issue. It is widely recognised that such issues cost money, time, and work hours for those involved in the design, planning, and construction phases (De Gaetani et al., 2020). Therefore, it is very important that, when implementing a new digital technology, this system is integrated and interoperable. There are several studies that address the potential benefits

of implementing integrated and interoperable systems (Rezgui and Zarli, 2006; Halfawy et al., 2004; Saini et al., 2019). However, there is little analytical evidence in the literature that actually supports the benefit of the implementation of an integrated system.

Several studies have explored the critical factors of successful implementation (Cao et al., 2017; Ojo and Pye, 2020; Sinoh et al., 2020; Van Nederveen et al., 2010). These studies primarily focus on specific countries and companies. Therefore, the applicability to other contexts uncertain. This current knowledge needs to be adapted to the context of this study in which the integrated system will be used. This contextualisation has not been sufficiently explored.

1.1. Case Company

This graduation research analyses what is required when transitioning to an integrated system that supports the project management in AEC companies. The research is conducted in collaboration with Drees & Sommer Netherlands. The developments within the organisation related to the transition to the new digital project management system is used as a case for the case study of this research. Drees & Sommer developed an integrated digital project management system. This system is designed to integrate project data of the various software systems that are used to perform project management activities. The system is used internally within the organisation. The transition process of this system started several years ago within Drees & Sommer Germany, and is slowly being introduced in an increasing number of locations within Europe. Drees & Sommer Netherlands is a very innovative company that wants to keep up with developments within their sector. Therefore, despite the possible challenges of implementation, they want to implement this new digital project management system. This implementation offers an unique chance to investigate the transition to an integrated digital project management system, to give insight in the process and requirements of such implementation at a construction consultancy company. The system developed by Drees & Sommer is discussed in detail in chapter 4.

1.2. Problem Statement

The knowledge gaps in the literature related to the implementation of integrated digital project management systems in a construction firm are discussed in this chapter. A problem statement is created from the knowledge gaps, and research questions are built around it.

1.2.1. Knowledge Gap

As interest in current building processes and new technologies increases, building companies worldwide are looking at ways to adopt new ideas and engage with new approaches. There has already been a considerable amount of research done on the application of specific technologies in the building industry. The research of Chen et al. (2022) gives a holistic overview of the technologies that have been implemented in the construction industry. Their research shows that digital technologies typically seem

to support and promote innovation in many facets of construction. The main advantages of employing these technologies have been identified as increases in productivity, quality, sustainability, health and safety, and job efficiency. Building Information Modelling (BIM) seems to be the one of these technologies that has been employed the most frequently so far.

Implementing BIM has many benefits, yet its adoption is still low (Sriyolja et al., 2021). Successful BIM adoption requires the AEC firms to invest in software, hardware, and training, and requires process investments also. In addition to significant investment, the low adoption also appears to be linked to the risks and challenges that may hinder its effectiveness (Ghaffarianhoseini et al., 2017). Research by Sriyolja et al. (2021) selected 15 categories of barriers which where associated with adopting BIM. These categories are cost, law, experts, interoperability, awareness, culture, processes, management, demand, project scale, technology, skills, training, contract, and standard. A number of these barriers are by Ghaffarianhoseini et al. (2017) also seen as the main reasons for the low BIM adoption, namely the lack of demand, cost, and interoperability. Since interoperability is a recurring theme, it is addressed in the following subsection.

1.2.1.1. Interoperability

Interoperability has become an area of study during the past three decades in response to the growing variety and incompatibility of information systems caused by innovations in technology within organisations (Poirier et al., 2014). The concept of interoperability can be defined as the capacity for multiple information systems to communicate and share information, use this communicated information, and access a third-party system's functionalities (Chen, 2017). Several problems arise when there is no interoperability between different software systems. Low technical interoperability will result in inefficient processes for the re-entry of codified data and hinder the generation of value because of data loss and incompatibility (Poirier et al., 2014).

Previous studies have looked into how BIM interacts with other systems, and as systems evolve, interoperability is a continuously challenging problem to solve (Shirowzhan et al., 2020). Even though the enormous variety of technologies that currently exist, the interoperability between them are still very limited. Because of this, it is critical to understand the potential for integration and interoperability with relation to implementation (Duarte-Vidal et al., 2021). One of the reasons why it is so challenging to share and exchange information between various building application systems is that there is no single standard integration method to create information interoperability (Juan and Zheng, 2014).

The research of Shirowzhan et al. (2020) shows that when taking into account the interoperability and compatibility key measures in a systematic manner, there is a significant gap in the BIM adoption theory. Because there is no clear guidance on how to implement and use these systems, the full potential of these systems is not used (Arayici et al., 2018). Therefore, companies are hesitant to invest in implementing new digital technologies.

1.2.1.2. Factors for a successful BIM implementation

As evident, there appears to be a growing trend in the AEC sector to introduce new technologies which reduce costs, improve efficiency, productivity and safety, and meet sustainability goals (Loosemore, 2014). Partly as a result, several studies have been conducted on implementing digital systems, focusing on BIM technology (Cao et al., 2017; Ojo and Pye, 2020; Sinoh et al., 2020; Van Nederveen et al., 2010). These studies only concentrate on one country, which makes it difficult to determine whether the findings from these studies can be considered when implementing a digital system in the country of application. The research of Cao et al. (2017) indicates that there is a difference between implementing digital systems in a small or large company in China. In addition, the research by Sinoh et al. (2020) has the limitation that there may be differences within the states in Malaysia studied due to unique factors. These factors could include the racial diversity, cultural norms, economic output, and building activity of the various Malaysian states. The same principles may apply here when translating a digital utility for use in another nation. Therefore, it is important that adjustments will be made to the context in which the system is implemented.

The factors that the studies identify as contributing to successful implementation focusing on a specific country, can be used as a starting point for the implementation in other contexts. For their research Sinoh et al. (2020) used the 15 factors that affect the implementation according to Haliburton (2016). Through the research, 11 factors emerged here which proved to be critical success factors (CSFs). These factors are divided into software and hardware, external coordination, management and leadership, and internal coordination. Based on the research by Ozorhon and Karahan (2017), the CSFs for implementing BIM in developing countries are availability of capable workers, effective leadership, and availability of information. While according to Darwish et al. (2020) coordination between different project groups, training and development, and awareness level for BIM have the most impact on implementation. In their study, 15 most critical factors were selected from a list of 51 factors extracted from other studies. The CSFs from the different studies have similarities in terms of leadership and availability of knowledge and capabilities. These factors are considered when starting the literature review, where the analysis into CSFs for successful implementation is deepened.

1.3. Research Objective

Research shows that there is a growing interest in implementing integrated software systems that contribute to project management. Studies on the implementation of these integrated software systems have so far tended to emphasise the benefit of such software. However, there is relatively little analytical evidence to support such assumptions. The objective of this research is to fill these gaps in literature. Therefore, this research aims to investigate and analyse what is required to obtain the benefits when transitioning to an integrated software system to support project management in a construction consultancy company. The goal is to uncover more about this element

in order to better understand the advantages and difficulties of adopting an integrated software ecosystem and how it affects interoperability. Besides that, it focuses on the aspects that are important to take to account when implementing such systems.

1.4. Research Questions

The following main research question is derived from the problem statement and research objective:

"What is required when making the transition to an integrated digital project management system in a construction consultancy company?"

The main research question of this research is further divided into three sub-questions. These sub-questions drawn up to answer the main research question are listed below.

SQ 1	*What are the differences between a fragmented and an integrated system in the context of transitioning to a digital project management system within a construction consultancy company?*
SQ 2	*How is the transition from working fragmented to integrated experienced by the employees of a construction consultancy company?*
SQ 3	*What aspects are important to keep in mind when making the transition from a fragmented to an integrated digital project management system in a construction consultancy company?*

1.5. Scope of the Research

It is of importance to get a better understanding about the what is required to get the benefits when transitioning to an integrated digital project management system. Drees & Sommer developed an integrated project management system, which will be used for this case study. Therefore, the scope of this research is to study their specific case and share with them what is required to obtain the benefits when making the transition to an integrated digital project management system.

The transition from the old (fragmented) way of working to the integrated digital project management will be discussed during the study. When implementing a new digital technology, challenges often arise in terms of interoperability between different functionalities. The study will investigate whether the implementation of an integrated system can reduces this problem. In addition, the study also focuses on the critical factors affecting the implementation of the new integrated system.

The new integrated project management system can be of added value in several areas, both internally and externally. Internally, it provides a system which aggregated and visualised all project information. This helps to create an overview. This is enabled by the creation of the common data warehouse to which all project data from the different software systems is connected. The complete operation of the system

is covered in chapter 4. When the new integrated project management system is implemented for a certain period of time in projects within the organisation, the data collected can be used to identify patterns. Externally, it will have more impact on the project documents shared with stakeholders. The system allows project information to be reported in a clear and uniform manner. In addition, this reporting can be fully customised to the customer's requirements.

When implementing a new digital system, one has to deal with software and data. At the start of the implementation of a new system, it is important that the end users can work with it. For this case, the users mainly work with various software systems to clearly document project information. After connecting the software systems to the Data Warehouse, the data is collected automatically. For the user, this data is visualised in Power BI. As a result, the users do not have to work directly with the different types of data themselves. As this study is limited to the the user and the work process during the transition to an integrated digital project management system, the focus of the research is on the software.

The report written for this research will show analytical evidence of what is required to get the benefits when transitioning to an integrated software system This will narrow the gap in literature on the evidence for this topic. In addition, it will provide aspects that are important to keep in mind when implementing a similar system, looking at the Critical Success Factors.

1.6. Thesis Outline

This research report starts with investigating the theoretical background of the topic by conducting a literature review which is covered in chapter 2. Next, the methodology of the research is covered in chapter 3. This discusses how the framework of Purup and Petersen (2020) is applied in this research. Chapter 4 discusses the integrated project management system developed by Drees & Sommer. The results obtained from the research by conducting semi-structured interviews are discussed in Chapter 5. This is followed by a discussion of the research in chapter 6. This consists of the implications, limitations, and recommendations. The report concludes with the conclusion in chapter 7, which provides an answer to the research question.

2

Literature Review

This chapter addresses the literature review conducted to explore the theoretical background of the study. The literature review contributes to identifying the differences between a fragmented and an integrated system. In addition, it provides an insight into the success factors that could potentially influence the implementation of the system investigated in the case study. The corresponding sub-questions are listed below.

SQ 1 *What are the differences between a fragmented and an integrated system in the context of transitioning to a digital project management system within a construction consultancy company?*

SQ 3 *What aspects are important to keep in mind when making the transition from a fragmented to an integrated digital project management system in a construction consultancy company?*

2.1. Fragmented versus integrated software

Several studies mention the fragmented nature of the traditional AEC industry (Lu et al., 2014; Rezgui and Zarli, 2006; Nuhu, 2021; Haron et al., 2015). There are different reasons why the functioning of this industry can be called fragmented and therefore inefficient. According to Alashwal et al. (2011) and Ribeiro and Fernandes (2010) the two main factors contributing to fragmentation in the construction sector are (a) the lack of cooperation between different parties and (b) the lack of process integration. These causes perpetuate the negative impact of fragmentation. Additionally, the study of Saini et al. (2019) emphasises that the absence of knowledge management (KM) systems contributes to collaboration within the AEC sector. This supports the lack of motivation between individuals and organisations as well as the lack of trust between organisations (Saini et al., 2019). In the study of Rezgui and Zarli (2006), the lack of technological support is also mentioned as a reason why the AEC industry is functioning in this fragmented and inefficient manner.

According to Holt et al. (2015), the necessity for efficient construction process management is demonstrated by the construction industry's project-based structure, dynamic

communication systems on projects, and the massive volumes of data maintained by general contractors. Advances in technology and environmental factors have possibly led to an increase in complexity in modern construction (Igwe et al., 2021). This complex nature of construction projects necessitates the physical separation of stakeholders, including suppliers, subcontractors, contractors, consultants, construction workers, and customer representatives. Furthermore, the evolution of AEC organizations has been significantly influenced by Information and Communication Technology (ICT). The consequences have been felt in a variety of areas, including employee behaviour, communication strategy, and organisational effectiveness. In order to meet the constantly evolving and complex requirements of the construction industry, ICT services need to provide in a user-friendly interface on a portable or mobile device that is integrated in a collaborative system or platform (Lu et al., 2014).

BIM, as integrated system, has been embraced by the AEC sector as a means of addressing the fragmented workflow, inadequate communication, and ineffective coordination (Campbell, 2007). In order to reduce fragmentation difficulties, BIM could offer a platform for parties involved in a construction project to share digital information (Nawi et al., 2009; Thanoon et al., 2003). It possesses the capability to transform the construction sector by introducing new avenues for coordination, cooperation, and information sharing, replacing the current fragmented method to integrated and collaborative (Umoren et al., 2019; Mao et al., 2007). Research by Haron et al. (2015) says that having information regarding a building in an integrated data environment is one of the main advantages of using BIM. BIM serves as a digital information storage system for project collaboration. It has been demonstrated that utilising a single integrated storage system for project data reduces errors brought about by inconsistent and disorganised project documentation (Khanzode and Fisher, 2000). This integrated data environment can also help to prevent needless data re-entry as the project progresses by serving as a central database for all parties involved in the building project. This setting encourages information-sharing and collaboration, which boosts output and streamlines the coordination process (Haron et al., 2015). Construction projects can reap benefits like reduced business costs and fewer errors through the use of emerging integrated technologies, like BIM (Nuhu, 2021).

Because of the AEC industry's fragmentation, interoperability—the capacity of various ICT technologies to interchange information—is becoming a growing issue (Lu et al., 2014). There is lack of complete information sharing during the life cycle of a construction project. While in a typical construction project, a lot of information has to be collected in many forms and has to be shared among the many different parties involved (Haron et al., 2015). There is deficiency of integration between different application when working together on projects between various organisations or within the organisation (Rezgui and Zarli, 2006). This potentially causes loss of information. Additionally, the fragmentation mainly causes problems that can be attributed to the "gaps" between the different phases of a project. Between these different phases, a lot of project information is shared which involves very costly and time-consuming feedback loops. The need to implement strategies that enable the integration of project processes has grown, leading to an increasing demand for software systems that sup-

port this integration (Halfawy et al., 2004). This provides an opportunity to improve construction management by integrating fragmented systems and efficiency. There is no doubt that these efficiencies are badly needed in this process (Igwe et al., 2021).

Haron et al. (2015) explained in his research that it is important to pay attention to standardisation when implementing an integrated software system within the construction industry. Implementing an integrated project management system can in fact result in costs being reduced and increase the quality of construction due to the better management process. In addition, it ensures reduction in time and reduces the likelihood of errors, leading to a certain increase in productivity (Kaner et al., 2008; Khanzode et al., 2008; Staub-French and Fischer, 2001).

For this study, in the context of implementing an integrated digital project management system, standardisation is defined as the process of establishing uniform procedures, protocols and formats for various aspects of project management. This includes the documentation and the process. Respectively, this involves developing standardised templates for the project-related documents and defining the standardised processes and workflows that ensure tasks are performed consistently and efficiently.

As several studies indicate, most companies in the construction industry still operate in the traditional, fragmented way because of the fragmented nature (Lu et al., 2014; Rezgui and Zarli, 2006; Nuhu, 2021; Haron et al., 2015). They use different software systems that are not interoperable with each other. Using integrated software systems can potentially save time and money. The risk of losing information when sharing documents between different parties and/or project phases can also be reduced, because all the data will be stored on an integrated data environment. This can reduces the interoperability issues. Therefore, it is important for companies in the AEC sector to increasingly work in a more integrated way, using technologies such as BIM.

2.2. Critical Success Factors

In technology, ”transition” refers to the process of moving from one technological system, platform, or method to another (Wu, 2022). This could involve upgrading software, migrating data to a new system, or adopting new digital tools and practices. The transition process typically includes planning, implementation, training, and evaluation phases to ensure that the new technology is effectively integrated into the existing workflows and that users are proficient in its use (Andersson et al., 2018; Westerman et al., 2011). Because the implementation is part of the transition process studies on the Critical Success Factors (CSFs) of the implementation of new software systems are examined.

Implementing new software systems involves many things and there are numerous factors that can cause potential problems, for example the cost of the system, inadequate project experience, or lack of available skilled personnel (Ghaffarianhoseini et al., 2017). For an implementation to be as successful as possible, there are several success factors that can be taken into account, as mentioned in section 1.2.1.2.

To identify which success factors would be critical for the implementation of Drees & Sommer's new developed system in the Netherlands, the existing literature was first examined. At a later stage in the study, the findings of the literature review regarding CSFs will be confirmed or disproved through the case study.

Since Drees & Sommer have developed a new integrated project management system for internal use, it is important to determine what similarities there are between this system and existing software systems. One of the systems that can be used by companies to collect all the data from their work activities, is the Common Data Environments (CDE). These environments, which are generally associated with building information modelling (BIM) workflows and construction projects, are digital information systems that centralise the storage and access of project data (Kirby, 2022). It offers clearly defined access areas for project stakeholders, as well as specifications of the status of the project and a thorough description of the workflow for the partial and approval processes (Preidel et al., 2017). By standardising the information exchange in a CDE for the stakeholders, this common environment is especially important in the Architecture, Engineering, Construction, and Operation (AECO) business to decrease fragmentation in the flow of information and access throughout the project (Radl and Kaiser, 2019; Parn and Edwards, 2019; Sik et al., 2017). The new developed system by Drees & Sommer is, just like a CDE, a software system which grand access to different project features and connects the data. However, this new developed system is only used within the organisation and other project stakeholders will not work in the system. In this respect, the new system is more similar to Enterprise Resource and Planning (ERP) software, as this is also used only within an organisation (ionProjects, 2020). The information system known as ERP was created for the integration and optimisation of processes (Naeem et al., 2017). Menon (2019a) and Naeem et al. (2017) describe that ERP is a software package which offers the ability to efficiently and effectively integrate all functions required in a single system with a shared database. All modules in the system can clearly communicate with each other and are interoperable. For the users of the new integrated system, the system ensures that all software systems used in managing a project are integrated within the system. The system can thus be seen as a combination of a features of CDE and ERP software system. Therefore, the implementation and critical success factors of CDE and ERP were assumed to be comparable to the system developed by Drees & Sommer.

The selection of literature in the study will be based on these two aforementioned systems. In addition, studies on BIM implementation are also considered for the selection of literature. Borrmann et al. (2018) explains that there is a model that defines four different levels of BIM implementation. In this model, different requirements must be met for each level of implementation. One of those requirements at is about data exchange. This exchange can be still file-based, but all files are managed on a central database. This corresponds to the new system developed by Drees & Sommer. Therefore, for the literature selection, studies on BIM implementation on document management were considered.

2.3. Important critical success factors for Digi-PM

Organisations must comprehend and address a variety of content specific CSFs, which are the requirements that must be fulfilled for an implementation process to be successful. The CSFs represent both management and business areas that require special and ongoing attention in order to achieve high performance in an organization's current operating operations and its future success (Ali and Miller, 2017). According to the research of Delgir and Pourjabbar (2018) it is important to study these factors specifically for every organisation and under each unique set of circumstances. In fact, it is essential to consider the context when determining the CSFs for the implementation of a new digital system.

Several studies were examined to understand the CSFs of an ERP or CDE implementation, in order to compile a list of the essential CSFs. The CSFs from the analysed studies were compiled into a table. The table can be consulted in appendix A. Most of the studies used to compile this table primarily address the implementation of the software in general, with a focus on management. Some studies have considered some more specific situations such as the construction industry or different countries/regions. These different perspectives are taken into account when determining which success factors may be critical for the implementation of the new integrated system of Drees & Sommer. To establish this, several variables have been selected. One of these variables include the dimension and perspective of the studies that were analysed. An other variable is how often the CSF has been mentioned in the analysed studies. In this case, the perspective carries the most weight, followed by the dimension and finally the references.

The factors analysed can be divided into three dimensions, humans factors, organisational factors, and technical factors (Menon, 2019b; Ozorhon and Cinar, 2015). A value of 1 to 4 is given for the dimension. Where 1 is technical, 2 is organisational, 3 is human/organisational, and 4 is human. The new system has been developed by Drees & Sommer itself and is already used in Germany, which means that the technical design will not get much attention during this implementation. Even though the requirements may have to be adapted to the Dutch context. The implementation will have a huge impact on the organisation which means it needs to be well prepared and conceived. Besides that, the implementation will never be successful if human resources, employees, cannot or will not cooperate properly. Therefore, the factors in this dimension are given the most weight.

For the perspective, a value is given between 1 and 3, where 1 (general implementation) fits somewhat more broadly to the situation of the company of the case study and 3 fits more specifically (the construction industry). This is based on the fact that the study focuses on implementation in a construction consultancy. In addition, Drees & Sommer Netherlands operates at all stages of the development of a project, from the initial idea to delivery and maintenance (Drees & Sommer, nd). However, during implementation, the system will mainly be used by project managers who operate from the realisation phase onwards. Therefore, research on the implementation within a construction company is a suitable perspective. Finally, a value is attached to the

amount of references. Where value 1 is given for 1 to 4 references, value 2 for 5 to 9 references, and value 3 for more than 10 references.

Adding up the values creates a list of the CSFs that are expected to be most critical for the implementation of the new integrated system at Drees & Sommer. This identification will be specific for this case. This value can be calculated as follows: *value of dimension + value of perspective + value of references*. The factors with a value above 6 will be considered critical.

After assigning the value to each CSF, a selection was made for the implementation of 37 CSFs. This selection is shown in table 2.1. The table shows the CSFs that have a value of 6 or higher. Most of the selected factors are part of the human & organisational dimension. They also appeared especially in the studies with a focus on the construction industry. These determined CSFs will be used in the case study, for the analysis of the transition. This involves examining whether the factors correspond to the participants' experiences of implementing the integrated digital project management system at a construction consulting firm. The case study will establish whether these CSFs are actually this critical for the implementation of the new integrated systems.

2.4. Chapter summary

The literature review aims to explore the theoretical background of the study. This involves considering the differences between a fragmented and an integrated system. It also identified the factors considered critical for successful implementation of an integrated system by previous studies.

The literature review provides a partial answer to the sub-question, *"What are the differences between a fragmented and an integrated system in the context of transitioning to a digital project management system within a construction consultancy company?"*. By several studies, the AEC industry is claimed to have a fragmented nature. This fragmented nature is thought to be inefficient. This fragmentation may be a consequence of a lack in technical support. Working with a fragmented system is often accompanied by interoperability problems. Data may get lost when data is shared between different software systems. Because the AEC industry is changing and projects are becoming more complex, an efficient management process is needed. An integrated system can contribute to this. The system can ensure better data documentation and coordination. Because the data can be integrated in a data environment, errors would be reduced and needless data re-entry would be prevented. In addition, interoperability problems can be reduced by making the system more integrated, allowing different systems to better communicate with each other. In the transition to an integrated system, it is important to pay attention to standardisation. Eventually, the integrated system can contribute to a reduction in costs and time involved in the project. For this study, standardisation within the implementation of an integrated digital project management system refers to establishing consistent procedures, protocols, and formats across various project management aspects. This

encompasses developing standardised templates for project documents and defining uniform processes and workflows to ensure consistent and efficient task execution.

In order to answer at the end of the study sub-question, *"What aspects are important to keep in mind when making the transition from a fragmented to an integrated digital project management system in a construction consultancy company?"*, this chapter has examined the factors that contribute to the successful implementation of a digital technology according to the literature. To identify the critical factors, a table has been compiled (table 2.1). This table will be used to compare the important factors emerging from this study. This will allow to state if the study confirms the CSF or perhaps contributes to the CSFs.

Research on the implementation of integrated software systems has, so far, focused on how beneficial such software is. However, there is relatively little analytical evidence to support such assumptions. This research therefore focuses on providing this analytical evidence by examining what is required to obtain the benefits when transitioning to an integrated software system to support project management in a construction consultancy company.

Table 2.1: Preliminary Critical Success Factors Digi-PM

	ID	Critical Success Factors	Value	Dimension	Perspective	Ref.	Calculation
1	C1	User training	10	Human	Construction industry implementation	12	4 + 3 + 3
2	C2	Top management	10	Human	Construction industry implementation	13	4 + 3 + 3
3	C8	Project team quality	9	Human/ organisational	Construction industry implementation	15	3 + 3 + 3
4	C9	Project management	8	Human/ organisational	Construction industry implementation	8	3 + 3 + 2
5	C19	Monitoring and evaluation	8	Human/ organisational	Construction industry implementation	6	3 + 3 + 2
6	C22	Project goals and scope etc.	8	Organisational	Construction industry implementation	7	2 + 3 + 2
7	C24	Change management	8	Organisational	Construction industry implementation	7	2 + 3 + 2
8	C20	BIM awareness among end-users	8	Human/ organisational	Construction industry implementation	6	3 + 3 + 2
9	C7	Effectiveness of project leader	7	Human	Construction industry implementation	1	3 + 3 + 1
10	C18	End-user involvement	7	Human/ organisational	Construction industry implementation	1	3 + 3 + 1
11	C26	External consultant	7	Organisational	Construction industry implementation	5	2 + 3 + 2
12	C27	Business plan/ vision/ goals/ justification	7	Organisational	Construction industry implementation	7	2 + 3 + 2
13	C3	Communication	7	Human	General ERP implementation	6	4 + 1 + 2
14	C21	Knowledge sharing	7	Human/ organisational	Construction industry implementation	2	3 + 3 + 1
15	C14	National culture	6.5	Human/ organisational	ERP implementation in Europe	1	3 + 2.5 + 1
16	C15	Country-related functional requirements	6.5	Human/ organisational	ERP implementation in Europe	2	3 + 2.5 + 1
17	C16	Client acceptance	6.5	Human/ organisational	ERP implementation in Europe	1	3 + 2.5 + 1
18	C28	Implementation methods/ strategies	6	Organisational	Construction industry implementation	2	2 + 3 + 1
19	C29	Vendor support	6	Organisational	Construction industry implementation	2	2 + 3 + 1
20	C61	ERP solution	6	Technical	Construction industry implementation	5	1 + 3 + 2
21	C60	Data accuracy and integrity	6	Technical	Construction industry implementation	5	1 + 3 + 2
22	C17	User acceptance	6	Human/ organisational	Integrating IT applications	1	3 + 2 + 1
23	C4	Skilled staff	6	Human	General ERP implementation	3	4 + 1 + 1
24	C5	Employee/personnel relations	6	Human	General ERP implementation	1	4 + 1 + 1
25	C6	Open and honest communication	6	Human	General ERP implementation	1	4 + 1 + 1
26	C44	BIM policy	6	Organisational	Construction industry implementation	3	2 + 3 + 1
27	C45	Productivity improvement	6	Organisational	Construction industry implementation	1	2 + 3 + 1
28	C46	Regulatory environment	6	Organisational	Construction industry implementation	2	2 + 3 + 1
29	C47	Budget for BIM implementation	6	Organisational	Construction industry implementation	3	2 + 3 + 1
30	C48	Project delivery methods that address BIM	6	Organisational	Construction industry implementation	1	2 + 3 + 1
31	C49	Organisational behavior	6	Organisational	Construction industry implementation	1	2 + 3 + 1
32	C50	Organisational learning capability	6	Organisational	Construction industry implementation	1	2 + 3 + 1
33	C51	Size of organisation	6	Organisational	Construction industry implementation	1	2 + 3 + 1
34	C52	Perceived industry pressure	6	Organisational	Construction industry implementation	1	2 + 3 + 1
35	C53	Managing external project risk	6	Organisational	Construction industry implementation	1	2 + 3 + 1
36	C54	Extend commission period and account for facility management	6	Organisational	Construction industry implementation	1	2 + 3 + 1
37	C55	Government support	6	Organisational	Construction industry implementation	1	2 + 3 + 1

3

Methodology

This chapter relates to the design of the study. It explains how the research question will be answered. The design of the research is based on the framework developed in a study by Purup and Petersen (2020). The foundation for this framework's construction is the action research methodology. This framework was chosen because the study is conducted by one researcher and therefore all activities are carried out by this researcher. In this framework, the results are reflected on after each run. This allows the direction of the research to be adjusted. This is very suitable for this research because no definite direction could be determined at the start. This is related to the case study, in which potential changes were possible. The explanation of the framework is first explained followed by an examination of the design of the study.

3.1. Research framework

The framework designed by Purup and Petersen (2020) consists of four main elements. The first element is the reflective researcher, who navigates the study based on ongoing reflections. This is the primary research approach. The second element is framing, which is a very detailed statement of the research theme, issue, and research question related to the research objective to be investigated. The next element concerns a workflow approach built on the principle of action research, which organises research activities (planning, acting, reflecting, and observing). The last element consists of a collection of research activities using different quantitative and qualitative research techniques that can be utilised during the study. For this research, only qualitative techniques will be used. The following section discusses how the 4 elements are applied to this study.

3.2. Application of the framework

The process of using the research framework to provide a solution to the specified research topic is described step-by-step in this section. During the study, the researcher adopted the role of reflective researcher since she is responsible for carrying out all activities during the study. This is one of the reasons why the chosen research method is very suitable.

3.2.1. Framing

The steps of for framing of the selected framework of (Purup and Petersen, 2020) were followed when defining the graduation research, in order to arrive at a suitable research question. First, the researcher's interests were considered in collaboration with the organisation; from this, the theme of digitisation emerged. From there, the topic around the transition to a digital systems was developed because Drees & Sommer is at the beginning of adopting a new project management system from its office in Germany. After identifying the problem and establishing the research objective, the research question was drawn up. The formulation of the research question is based on a literature review. The formulation of the study is not static; adjustments can be made to the research question during research activities.

3.2.2. Workflow

After the research question is defined through framing, it will be investigated by following the stages of planning, acting, observing, and reflecting. The study is divided into 3 loops. The first loop starts with identifying the current situation and knowledge regarding the fragmented and integrated systems. During the second loop the use of the integrated system will be investigated and determined, and in the third loop the knowledge will be synthesised and developed into an answer to the research question. The framework with these loops has been applied to this project and is shown in figure 3.1. All the activities of the project are combined per stage in this figure. The subsections 3.2.4, 3.2.5, and 3.2.6 will clarify which activities are carried out per loop and describe what the activities are per stage and how these activities are documented and analysed.

During all the loops the reflective researcher will be involved. When conducting the semi-structured interviews the experts and users of the new integrated project management system are involved. Based on the literature review and case study in loop 1, people are selected to be interviewed.

3.2.3. Multiple research techniques

For the study, it is important to work with different methods. Different situations need to be analysed; the current use of digital project management systems at the Dutch office, and the office in Germany where the integrated project management system is already in use. This will be done through qualitative research techniques only. A literature review will be conducted, but in addition, much attention will be devoted to conducting a case study. Part of this case study is conducting a preliminary survey, analysis of the new system, and semi-structured interviews. Conducting research is made more convenient by using different research techniques and approaches. The aim of using different techniques is to strengthen research through triangulation. However, when this is done, it is very important that there is good navigation between these different methods. By choosing the approach with a reflective researcher as the main research method, an opportunity is created to be able to use different research methods and have smooth communication among these methods.

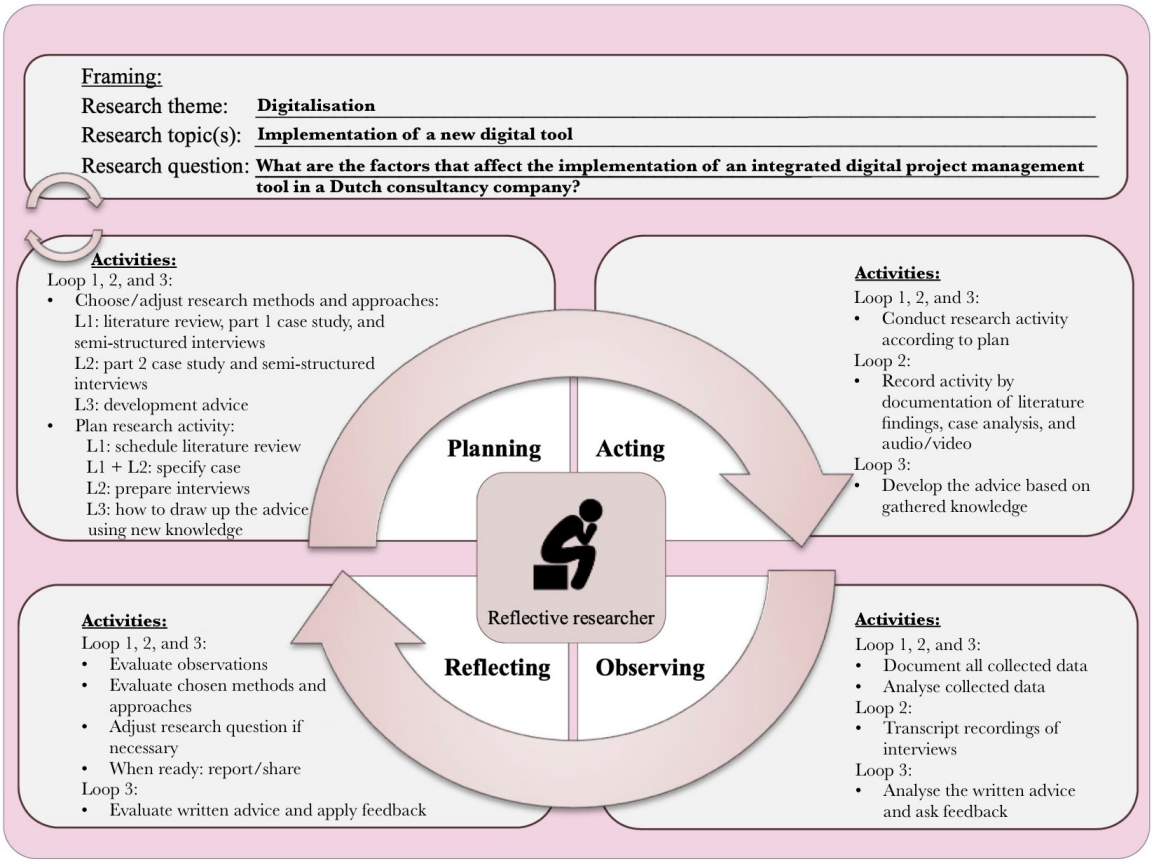


Figure 3.1: Overview of research framing and research activities

3.2.4. Loop 1: Investigating the state of the art and current practices

During loop 1, the current situation is identified through a literature review and the first part of the case study. This case study involves conducting a preliminary survey to gain insight about the current situation at the Dutch office. In addition the case study involves an analysis of the new integrated digital project management system. For the research on the current situation, the following activities will be conducted during the different stages of the loop:

- Planning: Plan literature review, and part 1 of the case study which includes a preliminary survey for insight on the current situation.
- Acting: Conduct literature review, preliminary survey and explore the current situation.
- Observing: Document the collected data and analyse this.
- Reflecting: Evaluate observations, methods and adjust research if necessary

To analyse the data, it must be documented during the observing stage. The data of the literature review is documented in an excel document which gives an overview on the topics, writers, journals, and findings in the literature. This data will be merged and used for the final thesis document. The observations of the activities during the case study are recorded to create and maintain an overview, from which conclusions are drawn. These conclusions, together with those from the literature review contribute to

the input for the next loop.

Refer to table 3.1 for an overview of what activities contribute to answering which sub-questions.

Table 3.1: Activities per loop per sub-question

		Loop 1	Loop 2
SQ 1	What are the differences between a fragmented and an integrated system in the context of transitioning to a digital project management system within a construction consultancy company?	Literature review & System analysis	Semi-structured interview
SQ 2	How is the transition from working fragmented to integrated experienced by the employees of a construction consultancy company?	Preliminary survey	Semi-structured interview
SQ 3	What aspects are important to keep in mind when making the transition from a fragmented to an integrated digital project management system in a construction consultancy company?	Literature review	Semi-structured interview

3.2.5. Loop 2: Identifying the use of an integrated system

During loop 2, the current use of the integrated project management system in Germany is investigated and identified in the second part of the case study through semi-structured interviews. The second part of the case study involves analysing the integrated system, the transition process, and the experience of working with the system. The following activities will be carried out for this goal throughout the loop's different stages:

- Planning: Plan part two of the case study with the semi-structured interviews for the use of the integrated project management system.
- Acting: Investigated the use of the system. Conduct interviews and record these (audio or video) + transcript recordings.
- Observing: Document the collected data and analyse this.
- Reflecting: Evaluate observations, methods and adjust research if necessary

In order to analyse the data it must be documented during the observing stage. The observations of the activities during the case study are recorded to create and keep an overview. The semi-structured interviews will be video recorded. The data of these interviews are transcribed.

3.2.5.1. Interview methodology

A qualitative study is conducted in the form of semi-structured interviews. The aim of the empirical study is to identify the process of transitioning from a fragmented to an

integrated system. This concerns analysis of the old, fragmented process, the experiences of users, and the new, integrated process.

3.2.5.1.1 Interview process

The aim of the interviews is to identify the differences between the old, fragmented system and the new, integrated system. This involves looking into the users' experiences before and after the transition, the transition process, and the important factors that users consider necessary for a successful transition. To obtain the right information for this, the next stages were followed: preparation, collection, analysis, and results. The overview of this process and the corresponding steps can be seen in figure 3.2. First, participants were selected based on their role and working experience with both the old and new system. Second, the interview data were collected by conducting the interviews, which were then transcribed. Subsequently, the interview data was analysed using a thematic analysis method which resulted in a set of themes. These themes can be subdivided into groups corresponding to the sub-questions. This analysis is discussed in more detail in the analysis section (3.2.5.3). Finally, the data analysis presented results which were divided by the sub-question groups.

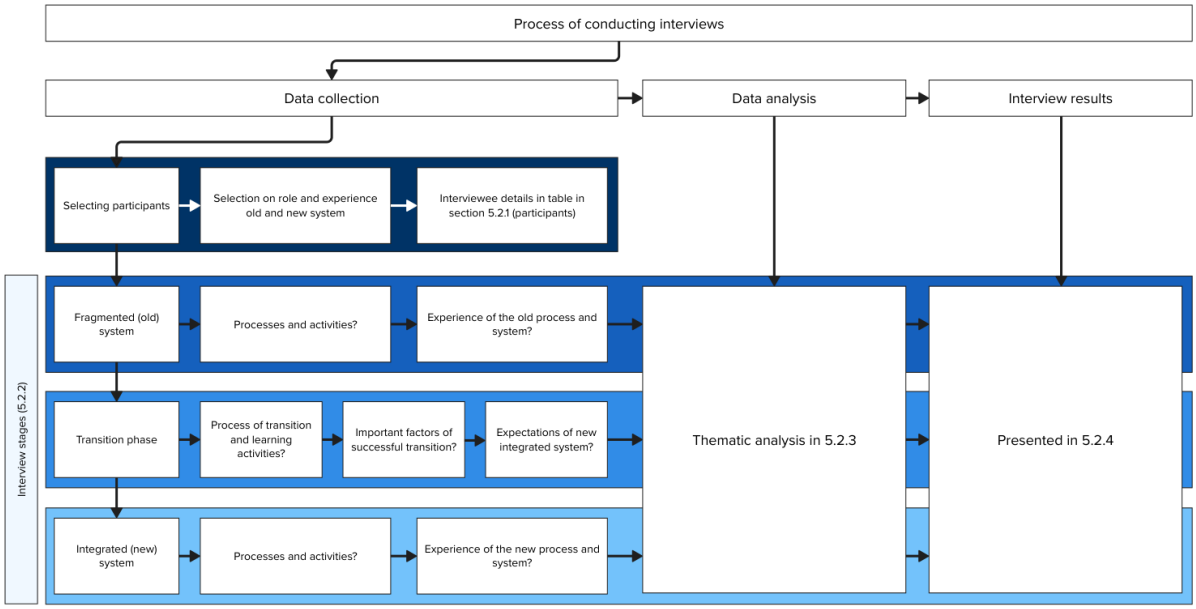


Figure 3.2: Process scheme of conducting semi-structured interviews

3.2.5.1.2 Participants

To conduct the interviews, participants were selected based on their experience with the new, integrated project management system (Digi PM). Digi PM has been implemented within the organisation primarily in Germany so far. Therefore, a number of users of Digi PM in Germany were selected for the interview. The users of the new system can be divided into three groups, related to the role they perform within a project. These roles are Project manager, Project lead, and digital manager. All roles have a different perspective on the use of the system because they use it for different

Table 3.2: Overview details of interviewees

	Role	Period working with fragmented system	Period working with integrated system
Interviewee 1	Senior project manager	1.5 years	1.5 years
Interviewee 2	Digital manager BIM manager Project manager	0.5 year	1 year
Interviewee 3	Project lead	4 years	2 years
Interviewee 4	Project manager	0.5 year	0.5 yea
Interviewee 5	Project manager	0.5 year	3.5 years
Interviewee 6	Project lead	1.5 years	3.5 years
Interviewee 7	Digital manager Project manager	0.5 year	1 year
Interviewee 8	Project lead	6 years	2 years
Interviewee 9	Digital manager	0 years	2 years

purposes. The project manager mainly is responsible for the activities of one project. This involves work from entering all project data, to creating an overview, and generating reports. The difference with the project lead is that this person is responsible for several projects. The project lead maintains the overview and supervises project managers of these projects. As a result, the core activities are creating overviews and reports together with their team. The role of the digital manager focuses more on the technical aspect of the system. The digital manager serves as a point of contact for the project manager or lead if they experience problems with the system during the project.

Within each role, three participants were selected to be interviewed. It is considered that focusing on roles with different perspectives will increase the validity of the results. The age range of participants is between 24 and 35 years. A detailed overview of the interviewee information is shown in table 3.2. As can be seen in the table, there is one participant who has no experience with the fragmented system. However, it was decided to include him as within his role he is completely dedicated to the implementation of the digital manager who, in addition to their project manager role, were educated to serve as supporters in the implementation of the new, integrated system. The numbers in table 3.2 below correspond to the interviewees referred to in the analysis and results section.

3.2.5.2. Data collection

The data collection is performed by conducting semi-structured qualitative interviews with open-ended questions. These interviews were conducted in English because that is the language of communication between interviewees and interviewer. The expected duration of an interview is between 45 and 60 minutes. All interviews were

conducted in an identical setting. Due to the distance between the interviewees and the interviewer, it was decided to conduct the interviews online via a video call. They were video recorded with the permission of the interviewees. The interviews were performed according to the interview protocol. The interview protocol is divided into three stages: before the transition, during the transition, and after the transition. This division enables a good comparison of the situation before and after, respectively fragmented and integrated. In the rare case of the interviewee who had no experience of using the old, fragmented system, only two interview stages of the protocol were addressed. These involve the questions about the period during and after the transition. Preliminary to the interview, the interview protocol and informed consent have been shared with the interviewees. For both the interview protocol and the informed consent, please refer to appendix C. After completing an interview, transcripts were made based on the recordings. These transcripts provide the basis for the data analysis, which is discussed in the following section. For the transcripts refer to appendix C.

3.2.5.3. Data analysis

To code and interpret the data from the interviews, a thematic analysis was conducted. The researcher first familiarised herself with the data by conducting the interviews and then transcribing these. To ensure correct interpretation of the dialogue, this was completed as soon as possible after the interview. To organise all the data into meaningful elements, the 'initial codes' were then generated. These codes were created using theory-driven coding. This refers to creating codes with research questions in mind Braun and Clarke (2006), in this case the sub-questions involved. During this stage, 303 codes were generated. These can be viewed in appendix C, table C.1. After generating all the initial codes, they were reviewed. Codes with similar meanings were merged into 1 code name. Once all had been reviewed, the codes were sorted and grouped into 25 'code categories', based on similarity. Next, the code categories were reorganised into 14 themes, which were defined on the basis of the sub-questions. Figure 3.3 show the coding tree which visualises the grouping of the different code categories and themes. These themes are divided into three groups: old project management process, transition process, and new project management process. With these groups, the right data can be easily selected for the analysis for each sub-question. Figure 3.3 shows to which sub-questions a group contributes. Defining both the groups and themes helps to create a focus in the extensive dataset. This provides an insight on which code categories need to be reviewed to obtain the relevant results per sub-question.

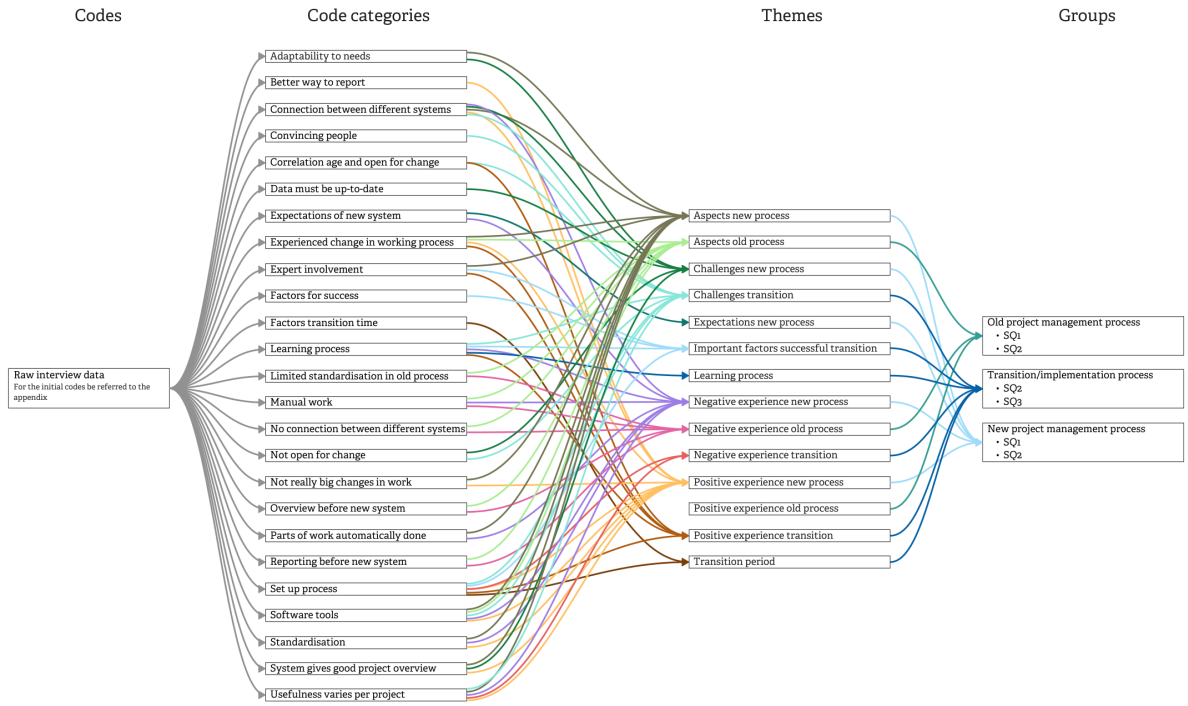


Figure 3.3: Coding tree of thematic analysis

3.2.6. Loop 3: Development of answer

During loop 3, all the new knowledge is synthesised and developed into an answer on the research question. This answer consists of an explanation of what is required when transitioning to an integrated project management system. This will include insights on what factors are of importance for the implementation, and what can be expected after implementing such a system. In order to develop this conclusion, the following activities will be conducted during the different stages of the loop:

- Planning: Plan how to review all the gathered knowledge.
- Acting: Translate knowledge acquired into written conclusion.
- Observing: Analyse the conclusion and ask feedback.
- Reflecting: Evaluate written report and add feedback.

All data collected and documented data during loop 1 and 2 will be analysed to identify similarities and differences. From this analysis, conclusions can be made, which will contribute to the development of the answer. This will be recorded in the thesis document.

4

Digital project management system Drees & Sommer

This chapter contains a software analysis looking at the operation and process. Part of the case study in loop 1 is the analysis of the newly developed system by Drees & Sommer. This analysis serves as input for answering the sub-question, *"What are the differences between a fragmented and an integrated system in the context of implementing a digital project management system within a construction consultancy company?"*.

Like many companies, Drees & Sommer is also experiencing the fragmented nature in the AEC industry. In order to move away from this inefficient way of working (Alashwal et al., 2011), it is important for the organisation to become more digital. The aim of this digitisation from Drees & Sommer is to ensure integrated and data-based project management. To achieve this, the organisation has established a digital process which is followed from the moment of data entry into the data sources until the creation of a finished report. This process is shown in figure 4.1.

The diagram shows that entering the project data can be done in different types of data sources: the database, applications , web-based systems, loose documents from systems such as, for example, Microsoft (MS) Excel, and Software as a Service (SaaS) Apps. The latter are cloud-based software delivery models where the development, maintenance, and software updates of cloud application are delivered over the internet by the cloud provider (Oracle, 2024). The data from these various data sources is moved and transformed via Automated Document Factory (ADF) pipelines or a storage account in preparation for the Extract Transform Load (ETL) process. In this process, all data from the different sources is collected and merged. This allows the project data to be analysed and reported (Nederland, 2024). This ETL process is performed in a central cloud database, called the Data Warehouse (DWH).

To achieve a data-related and structural connection between all sources and the DWH, the company developed a web application, Project Digital Management (PDM). PDM was developed to specify consistent structures for all project-relevant sources and define all data uniformly. An inconsistent structure can cause datasets to be mismatched

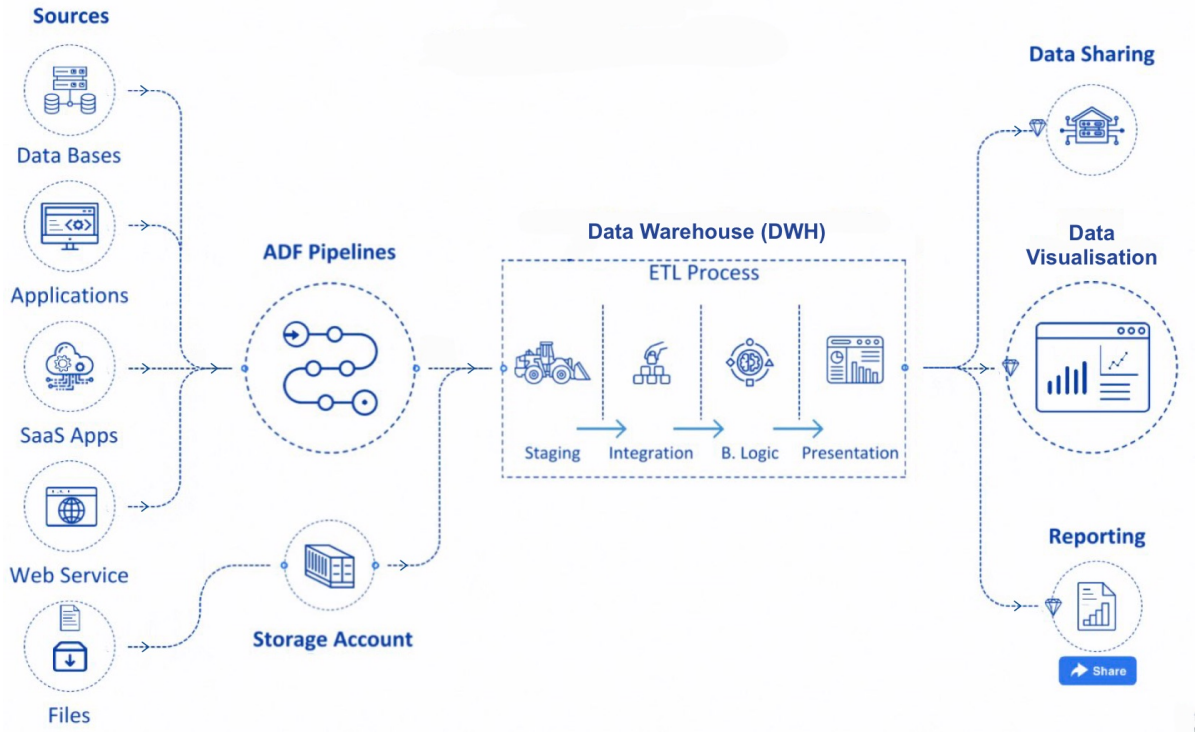


Figure 4.1: Flow diagram digital process (Drees & Sommer, personal communication, May 6, 2024)

which inevitably leads to incorrect or impossible allocation, filtering, and cross evaluation of the data.

This chapter will first discuss the project specific data definition process in PDM. Next, the sources used for project management activities and their integration process will be explained. It concludes by covering how all the project information can be merged into an overview and a report. All sections will address who is involved in the process.

4.1. Project Digital Management

At the start of a new digital project, a kick off is conducted with the project manager or project leader responsible for the project. This kick off is guided by one of the digital managers, the person responsible for the digital transformation. In order to collect all project data in the DWH, a new project is created in the web application PDM. When the project is created, all relevant project information has to be entered. The information mandatory to enter are the location of the project, the current project phase, and the project ID. The latter is the project number corresponding to the system in which Drees & Sommer records all project data. This ID connects all project details of the project captured in this system with PDM. This allows this project data to be entered automatically in PDM. Since there is no further need to work with this software system for the integration, the exact working of this system is disregarded for this study.

In PDM, all project details are recorded to allow the DWH to associate the project data from the various sources with the project. To connect the data from these sources to the project, it is necessary to define a project key in PDM for each source. This con-

nection makes it possible to display this data on the project dashboard at a later stage. If this project key of the project is not created, the data can only be stored in DWH but will not be associated with the project. In addition, before the various sources can be integrated with the DWH, a structure must be defined. This structure enables the data from the various sources to be recognised by the DWH. Figure 4.2 shows this process and how the systems communicate the project data. This chapter discusses how the different sources are integrated and how this integrated project data can be presented later.

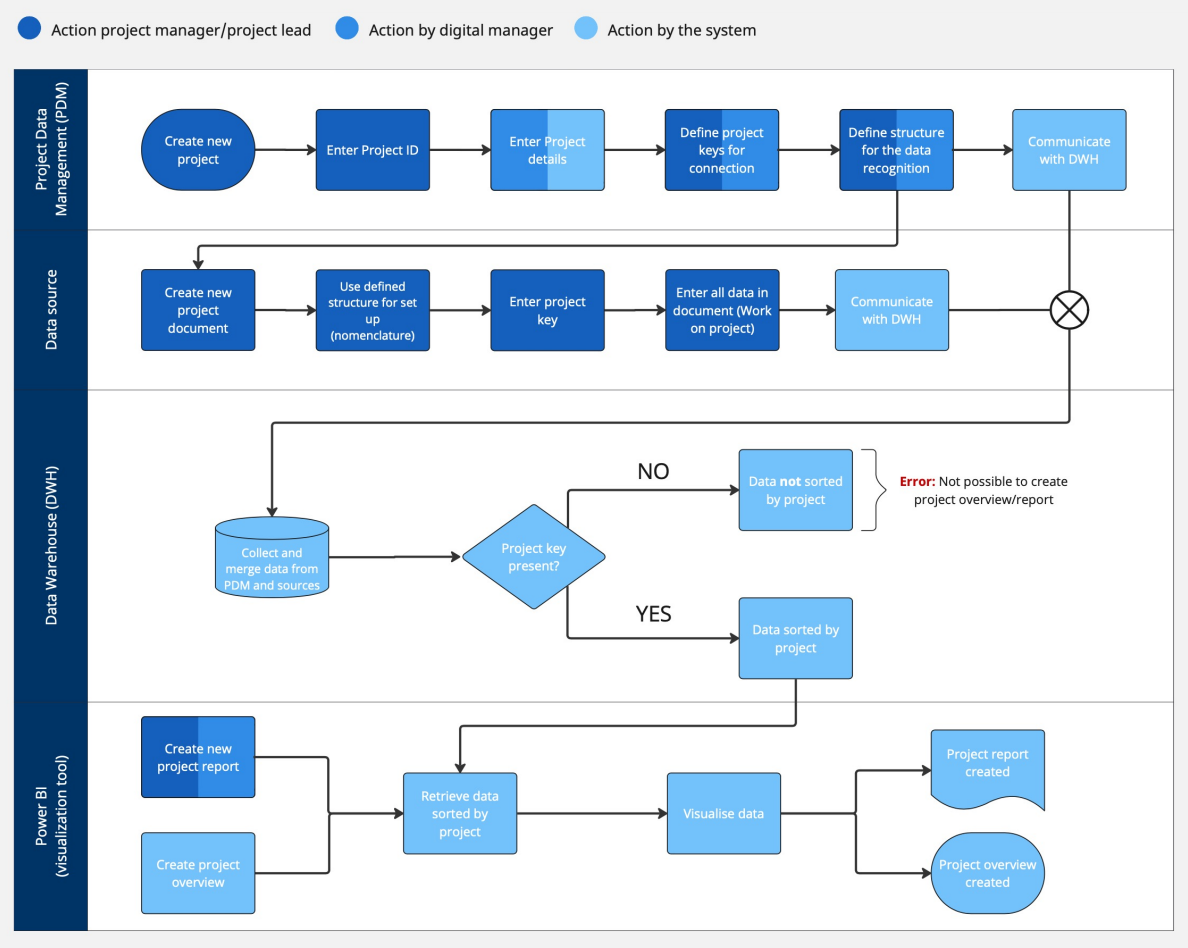


Figure 4.2: Process of creation and communication of project data between different systems

The definition and creation of a structure for the data is divided into four main attributes: Spatial Localisation (SL), Time Classification (TC), Project Participants List (PPL), and Procurement Plan (PP) (figure 4.3). For all sources that want to transfer data to the DWH, a reference to the main attributes should be created. This must be done according to the exact nomenclature that was defined when creating the structure in PDM.

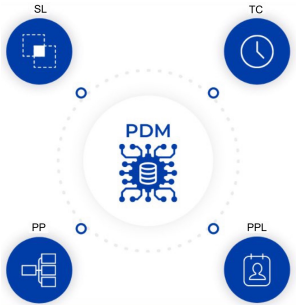


Figure 4.3: PDM main attributes (Drees & Sommer, personal communication, May 7, 2024)

The definition of this nomenclature for the four main attributes is shown in table 4.1. For each attribute a reference is defined and an explanation is given. The names defined during the kick-off must be used with exact reference by the project manager when working with the various software systems.

Table 4.1: Definition of reference nomenclature

Attribute	Reference name	Content of reference
Spatial localisation	BCG (Building Component Group)	Several buildings/complexes etc.
	BC (Building Component)	Individual building/unit/system etc.
	L (Level)	Level of a building component
	Z (Zone)	Zones of a level of a building component
Time classification	XY - phase name	Main phase number and name
	XY.Z	Number of the sub-phase
	Sub-phase name	Name of the sub-phase
Project participants list	Project function	Provided service
	Company	Full name of the company
	Address	Address of the company
	CompanyDWH	Abbreviation of company name
	CompanyDWH2	Abbreviation of company name abbreviation
	DWH	To grand permission to access dashboard (granted by filling cell with ”x”)
	Activity	To show active project member (shown as active by filling cell with ”x”)
	PersonDWH	Initials of name project member
	Person	Full name of project member
	Function of person	Function description project member
	Email	Team member e-mail address
Procurement plan	PP-Number	Number of the tender
	Trade group	Type of operations
	Status	Status of the tender procedure

The reference names to the procurement plan must be defined in MS Excel instead of in PDM. This procurement plan includes both the definitions and the procurement management for the tendering. To upload the defined nomenclature and synchronise them with the DWH, the MS Excel system contains a plugin, called ’Digi PM’ (figure

4.4). With a single press of a button, all data is shared and stored in the DWH.

Figure 4.4: MS Plugin to upload to the Data Warehouse

4.2. Project data integration

The new digital project management process developed by Drees & Sommer currently supports the management of costs, risks, planning, documents, processes, and BIM. All these activities can be carried out using different software systems. These are shown in figure 4.5.

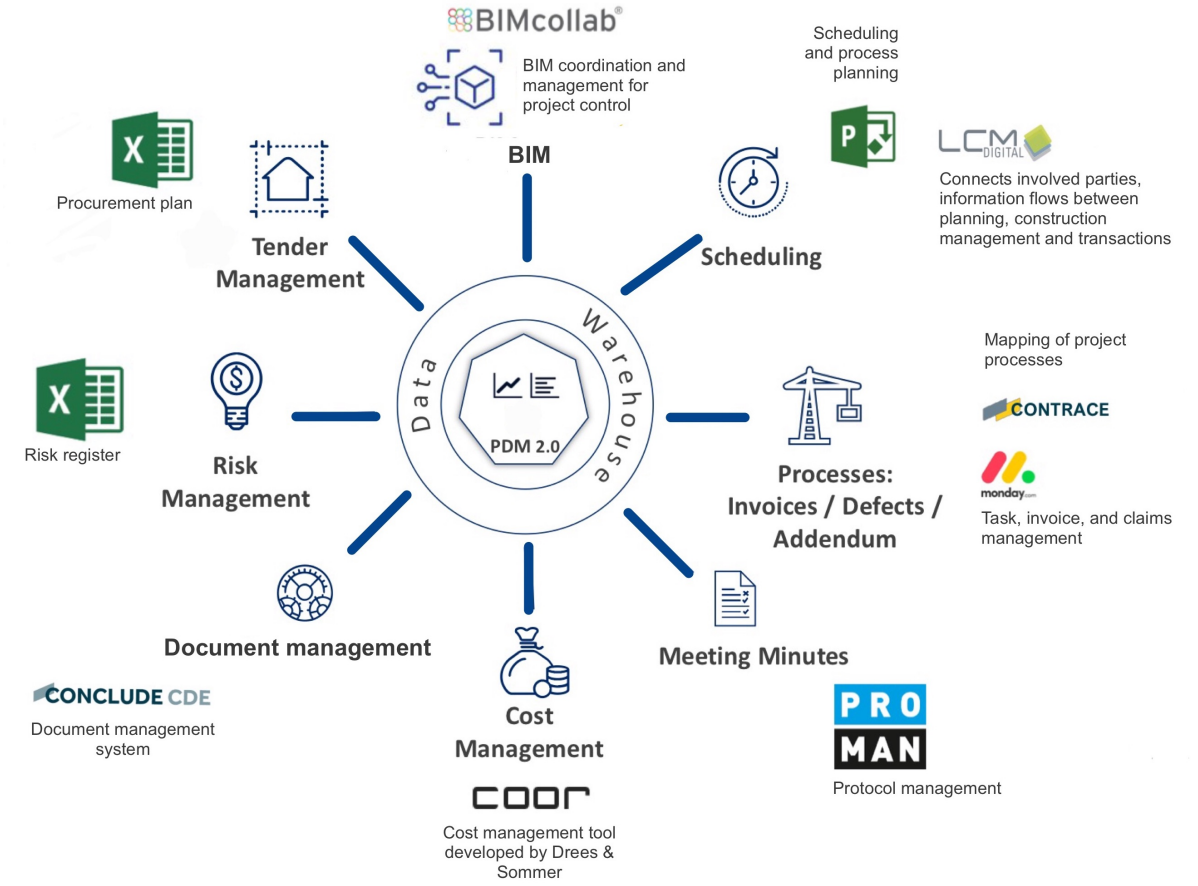


Figure 4.5: Source systems for new digital process

To ensure that all project data from these different sources can be transferred to the DWH, the sources have to be integrated. Integrating data is only possible when the DWH can recognise the type of data, allowing it to connect the data from different sources. As mentioned earlier, the DWH can recognise the type of data by having

a defined structure and nomenclature. Table 4.2 specifies for each software system what names must be used for the data to be recognised by the DWH, and therefore enable the project data to be integrated. It also indicates from which main attributes the nomenclature needs to be used.

It depends on the situation who is responsible for creating the new project files in the different sources, make sure the project data can be integrated, and later entering the data. There are two different situations for which the responsibility is being explained. In situation A, the project manager mainly works alone on the project. These are often smaller projects. In this situation, the project manager is therefore responsible for the creation of new project documents, integrating, and entering of all project data into the various software systems used.

In situation B, a project consists of several projects that are interconnected (multi project). These are larger projects resulting in a larger number of members in the project team. In this situation, the working students and junior project managers are responsible for entering the data. However, the project lead is responsible for managing the multi project. Therefore, the set up of all the new project documents in the different software systems is the responsibility of the project lead. Nevertheless, in both situations, the project manager or project leader is supported by the digital manager in setting up the new project documents with the defined references and with connecting the systems to the DWH.

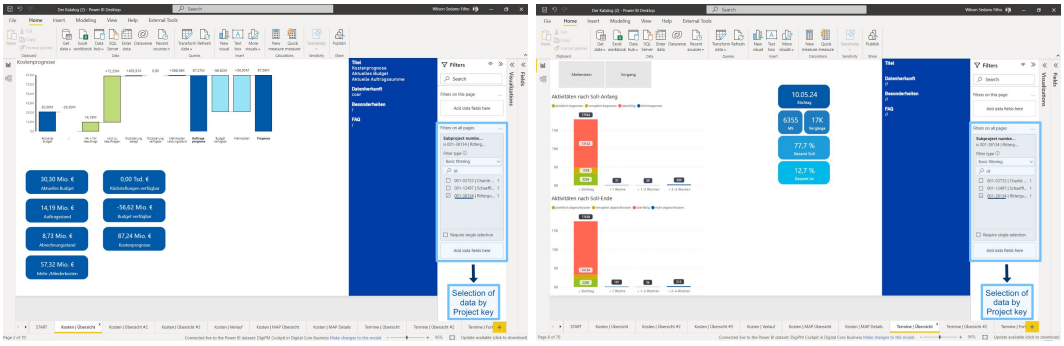
It differs per source type how the project data is shared with the DWH. For the SaaS Apps, an export to the DWH needs to be established once for each new project. After this is set, the project data is automatically uploaded to the DWH daily. This is not required for the Application and Web-service types. These have an automatic connection between their database and the DWH. This makes it possible for the DWH to automatically retrieve the project data once a day. The Files require the project data to be manually uploaded to the DWH. This can be done using the MS Plugin (Digi PM) from figure 4.4.

4.3. Presentation of project data

When all project data is shared with the DWH, it is possible for the DWH to integrate this data. This integrated data serves as the foundation for the project overview and project reports. This overview and reports are created using the visualisation tool Power BI. Power BI retrieves the integrated project data from the DWH, and visualises this data in the Power BI Desktop. This desktop is created for Drees & Sommer's projects and contains all the integrated project data. The project key can be used to select for what project(s) the data will be displayed. It provides a complete overview of all data from the various source systems covered earlier in this chapter. Figure 4.6 shows the desktop displaying the cost and schedule overview. This view is interactive, which means that when a particular compartment is selected, it displays more in-depth information about that compartment.

Table 4.2: Reference for integration data sources

Source type	Software system	Reference for integration
Application	COOR	**Field title or input:** Project key ID Category Sub-category Title Description Identified at (syntax: DD.MM.YYYY) Impact Qualitative assessment Profile Quantitative assessment Status Date monitoring (syntax: DD.MM.YYYY) Planned countermeasures and monitoring Responsible person **Use defined structure and nomenclature of attribute:** PPL, SL, PP
Files	MS Excel	Use special Digi PM risk register template which includes reference to DWH **Use defined structure and nomenclature of attribute:** PPL, SL, TC
	MS Project	**Column name:** Project key Actual duration % Completed Actual start Actual end Beginning End Duration Planned start Planned end Planned duration **Use defined structure and nomenclature of attribute:** PPL, SL, TC, PP
SaaS Apps	Conclude CDE	**Field title or input:** Project key Document delivery **Use defined structure and nomenclature of attribute:** PPL, SL, TC, PP
	LCM Digital	**Field title or input:** Project key ID Process StartDate EndDate Status Duration Trade Predecessors Successors
	Contrace	Use special Digi PM template which includes reference to DWH **Use defined structure and nomenclature of attribute:** PPL, SL, TC
	PROMAN	**Field title or input:** Project key **Use defined structure and nomenclature of attribute:** PPL, SL, TC
Web-service	BIMcollab	**Field title or input:** Project key Create new project via company account, thereby connecting to the DWH **Use defined structure and nomenclature of attribute:** PPL, SL, TC
	Monday.com	**Field title or input:** Project key Use special Digi PM template which includes reference to DWH **Use defined structure and nomenclature of attribute:** PPL, SL, TC, PP



(a) Costs **(b)** Schedule

Figure 4.6: Power BI Desktop

Besides serving as an overview, the Power BI Desktop is also the basis for creating the reports. The visualisations of the project data are retrieved from Power BI, after which it can be presented in various ways. These ways are shown in figure 4.7.

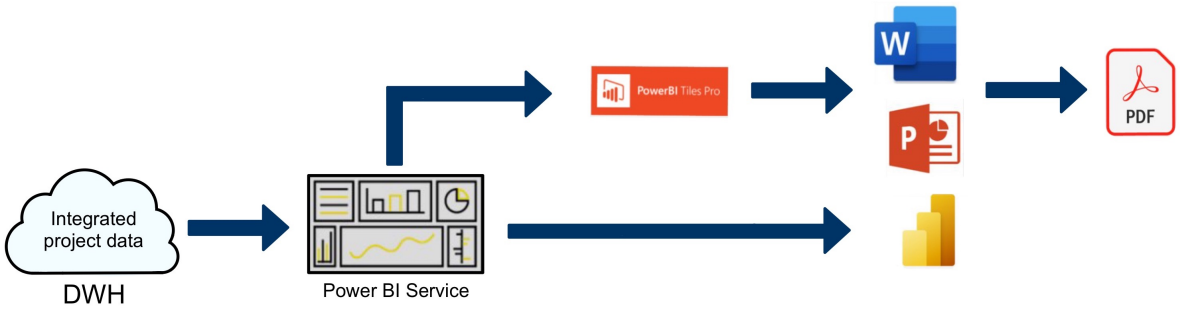
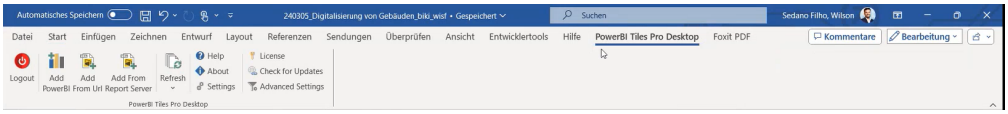
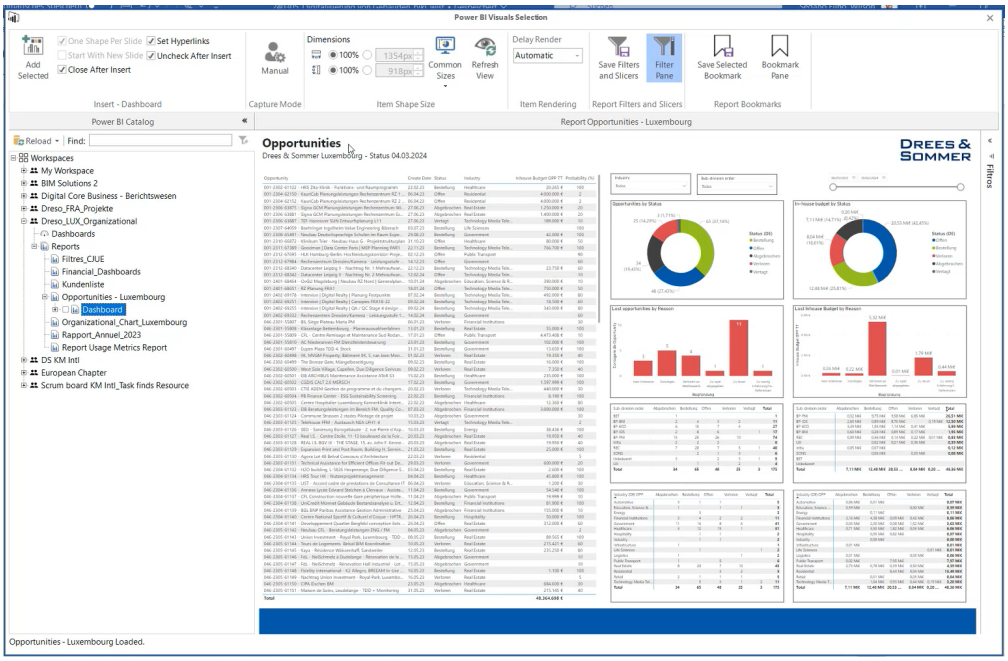


Figure 4.7: Different ways of presenting project data

Creating a report can be done in MS Word, MS PowerPoint, and Power BI. To create the report in MS Word and MS PowerPoint, a plug-in called 'Power BI Tiles Pro Desktop' is used. This plug-in is connected to the Power BI desktop. This allows all visualisations of the integrated data to be loaded into the Word or PowerPoint file via this plug-in. Figure 4.8 shows this plug-in and the catalogue where the visualisations can be selected by topic. After the report is created, it can be saved as a PDF file and shared with the client.



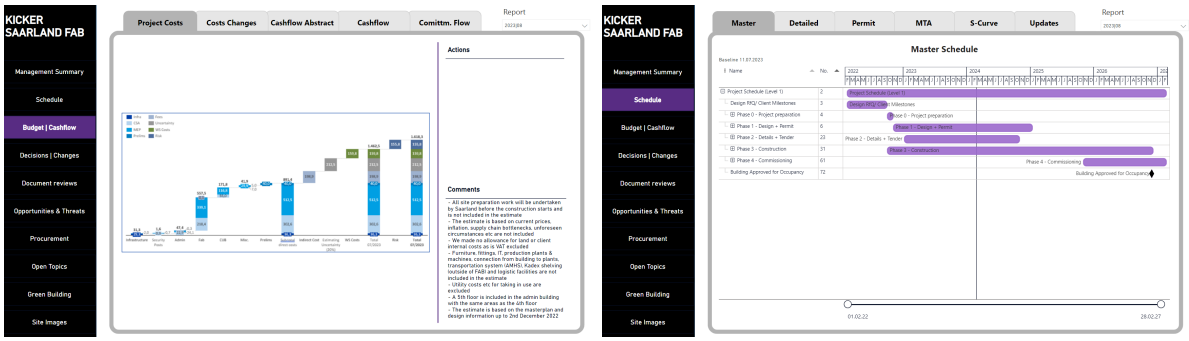
(a) Power BI Tiles Pro Desktop plug-in



(b) Power BI catalogue

Figure 4.8: Power BI connection to Word and PowerPoint for reporting

In addition to PDF files, it is possible to create an interactive report in Power BI. This can be generated by adding the relevant pages from Power BI desktop to a new file in Power BI. The report can be completely customised to the client's requirements, within the boundaries of the collected data. When the report is created, the client receives a hyperlink to the Power BI to the report once. This enables the project data to be uploaded daily from the data sources, via the DWH, to the Power BI report. As a result, the report is always up-to-date. Since this report is interactive, the client can decide what project information to look at. The client can select certain topics to get more detailed information about those topics. Figure 4.9 shows an example of such an interactive Power BI report.



(a) Costs overview

(b) Schedule overview

Figure 4.9: Interactive Power BI report example

In both situation A and B, the digital manager at the relevant location is responsible for creating the Power BI reports. This is done in consultation in situation A with the project manager and in situation B with the project lead. The project manager/project lead indicates to the digital manager which components should be included in the report, after which the digital manager develops the report.

4.4. Chapter summary

When reflection on the integrated digital project management system developed by Drees & Sommer, it can be stated that it is generally easy to use. In addition, thought was given to ensure the transition would not involve too many changes. The system makes extensive use of familiar systems, making it easier to implement for users and reducing the time required to learn to work with the systems. However, retaining familiar systems causes the sources to be connected to the DWH in different ways. This results in more potential confusion when connecting the system and the DWH. A structure and nomenclature must be defined per project so that the project data can be integrated into this DWH. Since not all definitions are the same for every project, it increases the chance of using the structure and/or nomenclature incorrectly. This part of the system is therefore error-prone, because if the reference is wrong, the DWH cannot integrate the data from the different data sources. However, there are templates to work with for a large part of the project documents. These standard templates ensure that work can be done easily and, in addition, the correct references have been established for the connection with the DWH.

Besides the fact that at the beginning of a project all connections are made and all definitions are defined, the work process has remained relatively the same. The biggest change is in the standardisation of the process and the transfer of the data to the DWH. By integrating the data, it is possible to partly automate the process. This saves a lot of time when creating a project overview or project report. To create a project report, a design needs to be made once with the input from Power BI. This report can be continuously updated, with the visualisations being adapted to the data available in the DWH at that moment. The reporting method can be adapted to the client's preferences within the capabilities of the data. This adaptability is of importance, considering that not all clients are open to the digital report. This is further discussed in chapter 5.

As a result of the analysis of the integrated project management system, part of the sub-question, *"What are the differences between a fragmented and an integrated system in the context of transitioning to a digital project management system within a construction consultancy company?"*, can be answered. The analysis revealed that standardisation is required to enable data integration. If there is no standardisation, the probability that data connections are not made properly is high. It has also emerged that an integrated system requires more time to start a new project than a fragmented system. However, the integration enables the automation of more work, which ultimately saves time. It can therefore be said that the benefits of an integrated system become apparent over a longer period of time. Therefore, the transition to an integrated system will be particularly profitable for long-term projects.

5

Practical study

The purpose of the practical study is to identify the transition from a fragmented to an integrated system. This involves considering the experience of system users and the factors important for successful transition. The qualitative research is conducted by means of a preliminary survey and interviews with those involved. The sub-questions to be answered in this chapter are listed below.

SQ 1 *What are the differences between a fragmented and an integrated system in the context of transitioning to a digital project management system within a construction consultancy company?*

SQ 2 *How is the transition from working fragmented to integrated experienced by the employees of a construction consultancy company?*

SQ 3 *What aspects are important to keep in mind when making the transition from a fragmented to an integrated digital project management system in a construction consultancy company?*

The entire newly integrated project management system is referred to by its users as Digi PM. Therefore, the system presented in chapter 4 will be referred to as Digi PM throughout the rest of this study.

5.1. Preliminary survey Drees & Sommer Netherlands

Part of Loop 1 of the research is to get a good understanding of the current situation at the Dutch office. In order to assess the current situation of digital project management within Drees & Sommer Netherlands, a preliminary survey was conducted. This survey was not designed to do any validity but to get to know the context of the project managers perception of the situation. The study was carried out among the population size of 30 project managers within the Dutch organisation. The sample size is 29 project managers. The study examines the current work activities of digital project management and which software systems and documents are used for these activities. The survey also examines project managers' attitudes towards transitioning to

a new integrated digital project management tool. It could be identified that the initial perception is that there is a fragmented way of working within the organisation in terms of digital project management and that standardised documents and processes are limited available (34%) and able to find (45%). Possibly because of this, a high percentage (97%) of project managers are positive about the transition a new integrated digital project management tool. They have an initial anticipation of the improvement. However, the problem with this survey is that respondents have not yet used the new tool and do not know what the transition process entails. Therefore, no quantitative evidence can be extracted from this survey. For a more comprehensive explanation of the survey and results, please refer to appendix B.

5.2. Interview users Digi PM

The qualitative research is a practice-based study that addresses the experiences about the transition from a fragmented to an integrated project management system. As part of Loop 2 of the study (see section 3.2.5), the qualitative research is performed by conducting semi-structured interviews with users of the newly implemented system. This section present the interview results.

5.2.1. Interview results

This section presents the results of the thematic analysis for each sub-question. First, the results of the comparison between the fragmented and integrated system are discussed. Next, the findings on the employee experience are addressed. Finally, the most important factors for a successful transition resulting from the interview are presented. For each of these topics, the data collected in different code categories were analysed in depth. To obtain the results, data from different code categories were considered for each sub-question. Please refer to appendix C for table C.2, which shows what code categories provided input for the results for each sub-question.

5.2.1.1. Fragmented versus integrated

For the sub-question on the differences between a fragmented and an integrated tool, two situations were compared. The situation in which the employees worked with a fragmented system and a situation where they worked with an integrated system. For this comparative study, data on a subject from both before and after the transition were examined. This comparison was carried out for the following four topics: standardisation, connection between different systems, project overview and reporting of a project. To make the comparison, interviewees' statements on the subject were placed side by side. These statements are about the topic in the situation before and after the transition. The most significant results will be discussed per topic.

5.2.1.1.1 Standardisation

According to the results from the interviews, there appeared to be little standardisation in the process before the transition. There were no official standard templates

that were actually used for the various activities. Instead, old project documents were used as templates. This resulted in possible errors in the document being carried over into the new project.

”Everything has to put in the right data, and I think it’s now more in a framework, so everyone has to put in the data in this specific framework (...) is always in the same framework, because we need it for the data drop into the power BI.” (Interviewee 3).

Because of the transition to the integrated system, there was need for more standardisation. It is important that their are standard templates for the project documents in order to enable the system to understand them and communicate with the database.

Table 5.1: More standardisation with integrated system

Statement interview - fragmented	Statement interview - integrated	Differences
”There were efforts to standardise things, especially for Excel. They, Drees & Sommer, for example, developed like Standard Excel sheets for, let’s say, a decision template for a client or something. And they were barely used across all projects. But every project, sort of recompleted these excel sheets or these standardised things for themselves.” *Interviewee 6*	”Everything has to put in the right data, and I think it’s now more in a framework, so everyone has to put in the data in this specific framework and don’t have to write a text in that, and or something others. And time scheduling is always in the same framework because we need it for the data drop into the power BI.” *Interviewee 3*	With the transition to the integrated project management tool, standard templates have been developed. These should not be modified. This is because the data entered into the tool must be able to be communicated with the other systems.
”Sometimes there were standard documents, but they were used from project to project to project, and not in a clear version. So, all the mistakes that were in the previous projects were getting into the newer ones.” *Interviewee 5*	”Yes, the more standard, standardised templates. They’re just pretty good, and easy to work with. You know that the experts in Drees & Sommer made that template, and it’s not around the problems of past projects in other templates, that were used.” *Interviewee 5*	By introducing standard templates to work with, employees will be prevented from having to use documents from previous projects. As a result, errors from these documents will no longer be carried over.
”People, we are no single source of truth. That was just one of the main reasons you always have, there’s always a certain overlap between data.” *Interviewee 7* ”They always had their own tools, and they did put the data into this tool. And this did lead to the problem that there was very much manual, and not centralized data input. ” *Interviewee 7*	”And for me as well, because we all have our own established ways of working, we name our data in that way, order our data in that way and stuff like this. But Digi PM requires us to standardise all these things, to adapt to new standard, and then also to be disciplined.” *Interviewee 6* ”So, this helps us to get more and more into the direction of having like single source of truth.” *Interviewee 7*	As standardisation forces employees to work in a specific way, data input becomes more centralised. With this change, there will be more and more uniformity in the data produced.

Table 5.1 show the comparison of standardisation with the fragmented and integrated system. Because of the use of the standard templates, each project starts with empty templates. This prevents errors from previous projects being included. Furthermore, the standardisation ensures that employees all operate in a similar way. This results in greater uniformity in data production. This both improves the quality of work.

This standardisation was addressed in every interview. It was mentioned that in the beginning, it is necessary to become familiar with the standardised approach. However, it is experienced as a positive change. A digital manager interviewed stated that ”standardizing stuff leads to more efficient processes” (Interviewee 9). The change to more standardisation is considered positive because it simplifies the work and makes

it more efficient.

5.2.1.1.2 Connection of data from different systems

Prior to the transition, there was no connection between the data of the different software systems, and there was no central location where all project data was stored. As a result, there was a high risk of losing project information.

"And a lot of the information that was previously lost, is now stored and can be accessed later. Which is always better than just losing it." (Interviewee 9).

Because the data of all the different software systems is stored on a central data base, the risk of data loss is decreased. Besides, the connection of the data in the database creates the possibility to have an better overview over all the project data. This is addressed in table 5.2.

Table 5.2: Data of different systems now connected

Statement interview - fragmented	Statement interview - integrated	Differences
"The other big topic that we had before we used this standardized method, was that there was no connection between the tools and databases." *Interviewee 7* "there wasn't really one big platform where we could combine all the tools together. So yeah, it was just all the tools separated. But we already did use, like share point's or like data platforms, cloud platforms. But all one tool and not combined together." *Interviewee 4*	"It's more connected with each other. Like all the information gets more connected with each other. (...) And now, the Power BI report can combine all the details, and give you a better overview of, why are things like they are right now. So it's a better overview, you can combine more information. And the tool can do the work for you." *Interviewee 4*	When working in the fragmented way, all software tools work independently of each other. There is no connection between the tools or with a common data storage. However, this is the case with an integrated system. Here, all data from the various software tools are stored in a single database, making it possible to visualise them as a whole.
"Because this was not that professional, we were sometimes in situations where, like a working student, or something like this did develop a database, and then he decided to leave the the company. Then we had big problems, because this knowledge was just gone within days." *Interviewee 7*	"And a lot of the information that was previously lost, is now stored and can be accessed later. Which is always better than just losing it." *Interviewee 9*	Part of the transition to an integrated system is the connections between different systems. There will be less loss of data, as the software tools are connected to a database on which all data is collected.

The biggest difference between the fragmented and the integrated process is the connection of the data from the different software systems. With the connection between the software systems and the database, the project data will be compiled together. As a result, the amount of data losses will be reduced and the project data can be visualised as a whole.

5.2.1.1.3 Project overview

Since no connection could be made between the data of the different software systems prior to the transition, it was not possible to get a complete overview of the project information without going through all the different systems. All project information had to be obtained from the different systems. The process for this was therefore com-

pletely manual.

"At the moment I could go into the Power BI, and check all the data, and I have all set, and can see the whole project. Before, I had to go into every tool, and see the data." (Interviewee 3).

All project data is collected on a central database and connected to each other. This ensures that the project manager/lead no longer has to manually review every source to retrieve the relevant project information. In addition, this connection enables visualisation of this project data as a whole, which was not the case with the fragmented system (table 5.3).

Table 5.3: More easily obtained project overview

Statement interview - fragmented	Statement interview - integrated	Differences
"So, you had to go and check all the different documents and all the different data and stuff and not just have one. One thing to see it all." *Interviewee 2*	"We do use a dashboard in a project. It's just by one click, you can change the topic you want to see. And you have like all the open to do's, the scheduling, the risks all in one place. And yeah, it didn't, we didn't have that before." *Interviewee 5*	Because the fragmented system has no connection between the different tools, it cannot give a total overview of all project data. By creating the connection between the different systems, it can be collected on a database and communicated as a whole. As a result, all project data can be consulted in one place.
"We had to pull the data from the cost report in COOR and fill it in the quarter report. We had to use the time scheduling, (...) Afterwards you have the whole overview over the project in this terms quality, cost, scheduling, and an overview. But we had to do this on our own." *Interviewee 6*	"So it's all in one place and I don't have to go in all the different tools, but it's all in one place and I can just click." *Interviewee 6* "At the moment I could go into the Power BI, and check all the data, and I have all set, and can see the whole project. Before, I had to go into every tool, and see the data." *Interviewee 3*	By connecting the various systems in the integrated process, employees no longer need to collect all project information in one place themselves.

By creating this connection to the central database and integrating the project data, certain manual work is automated. This results in a reduction of time spent on creating a project overview. Moreover, it contributes to reducing the risk of errors, as the human factor is eliminated when aggregating data.

5.2.1.1.4 Reporting of project data

Previously, the use of the fragmented system caused a lot of time spent by the project managers/leads on collecting the project data to generate a report for the client. The connection between the project data and the central database of the integrated system makes it possible to automatically combine and visualise the project data. A visualisation tool linked to the central database creates a dashboard displaying all the project information. This visualisation tool can be used to partly automatic generate the reports.

"Now we use Power BI for reporting. And either we send out the link to the client, and he checks out the report digital, as a Power BI report. Where he can scroll through

all the stuff." (Interviewee 5).

Because all the project data is visualised automatically in the visualisation tool, the report can be created much faster. This report can be shared with the client and stays up-to-date with the project data sent to the central database. As stated it is also possible to export this Power BI report as a PDF for the clients that are not used to the digital tools. This is mentioned in table 5.4), alongside with the quality increase.

Table 5.4: More automated creation of project report

Statement interview - fragmented	Statement interview - integrated	Differences
"We worked a lot with separated tools. (...) And yeah, we had a, we did a lot of manual work to collect all the data from all the different tools. And to combine them in reports," *Interviewee 6*	"Now we use powerBI for reporting. And either we send out the link to the client, and he checks out the report digital, as a powerBI report. Where he can scroll through all the stuff. Or if the client is not as firm with using digital tools, we just transform the powerBI report into a PDF, and send it to the client." *Interviewee 4* "Just by one click you can share everything, that you've just been working on." *Interviewee 5*	First, the process of reporting was to manually go through different tools to combine them into reports. When changing to an integrated process, a visualisation tool, Power BI in this case, can be used which is connected to the database. This makes it possible to create a report automatically, with little or no manual work.
"Well, we had to synchronise all the information together (...) we have to take all the documents, collect all the most important information, and put them into the PowerPoint. So, yeah, it was always like a process of making a presentation." *Interviewee 4* "we kind of were writing the report in Word and then as a PDF file, we were submitting it to the client." *Interviewee 1*	"Before, it was manually with, for example, the PowerPoint chart or something and now it's with using power BI for example. So, you have not like this, just a classic report that you print out or you just have it like that. You can interact with the data." *Interviewee 2*	In the previous process, reports were created manually and shared with the client in PDF. Because in the integrated process all project data can be communicated using the visualisation tool, the reports can be made interactive. This allows a client to select project information relevant to him/her.
"At the end-end, the assistant or yeah, assistant is looking into like the quality check if everything is alright and looking good." *Interviewee 2*	"Yeah, the quality check. Is the, this part is like more or less not existent anymore. You don't have the quality check a lot because like, the alignment of all the different elements on the report is always the same, just the data inside it changes. But the layout is always the same. So, you don't have to make like the layout new or yeah. So, the quality check is way less." *Interviewee 2*	Because the reports in the new process are automatically developed in a standard format, it is no longer important to subject them to a quality check after creation. Assuming that all data has been entered correctly in the various software tools.

As a result of the automated data collection and integration, users no longer need to collect the project data themselves. In contrast to the old system, the overview and report created by the new system are interactive. This makes it possible to filter the project information displayed and select specific items for an more detailed explanation of the project data. The automation results in an decrease of time spent on the creation of the project report. Also the quality increases since the alignment of all the elements in the reports stays the same. Only the project data changes.

5.2.1.2. Employee response

All the experiences of the interviewees were listed for the collection of results for the sub-question on employee response. These can be divided into expectations of the

change to an integrated system and actual experiences. The experiences can be divided into three categories, which are experiences with: the transition process, working with the new system, and the learning process. This division and the corresponding results for each category are presented in figure 5.1.

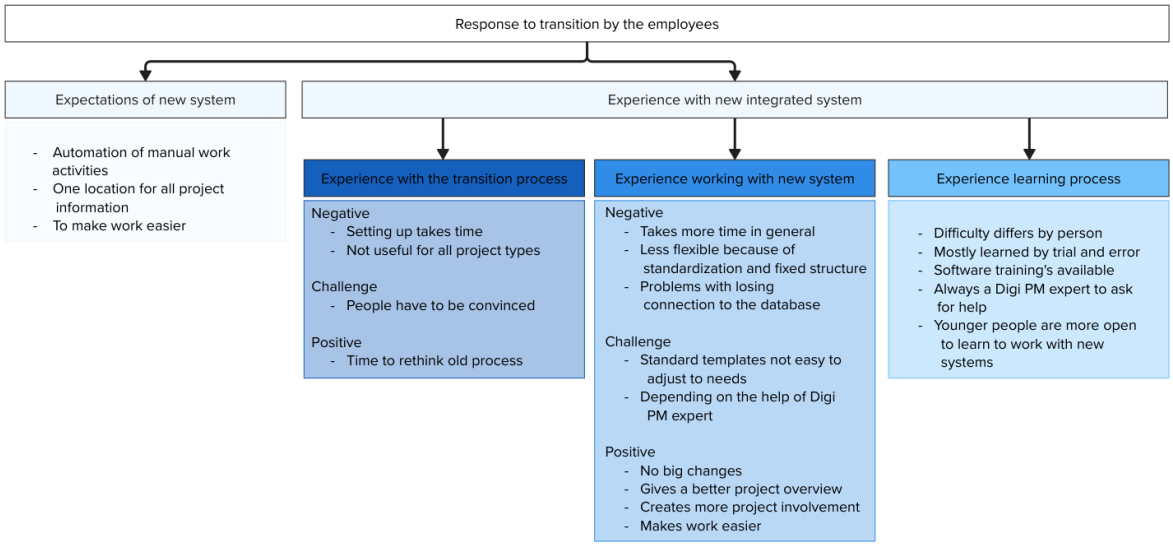


Figure 5.1: Breakdown diagram for results of employee experience

For each category, the most important employee experiences will be presented in the following paragraphs. The quotes used in this paragraph are retrieved from the interviews. For a more quotes and explanation of each single experience mentioned, please refer to table C.3 in appendix C. This table contains quotes for the relevant topic with an explanation of the result.

5.2.1.2.1 Expectations

At the time the employees became acquainted with the fact that there would be a change in the project management system, they had a certain expectation of what the new system would provide them.

"especially for the data mining that in a kind of in the ideal case I would only have to click one button and then the report would kind of mine the data from the different applications." (Interviewee 1).

It can be inferred that the expectation of the system is that manual work is decreased by the implementation of the integrated system. This would facilitate work and ultimately save time. This is indicated by several participants, shown in table 5.5.

The biggest expectation was that connections could be made between the different software tools, allowing all project information to be collected in one location. Due to these connections, the system would make it possible to automate multiple tasks.

Table 5.5: Expectation of transition

Statement interview	Explanation of result
”My expectation yeah, and also getting some dashboard that update themselves that I can also give (...) kind of proper feedback to the client if he needs some information or also for me to monitor the project. (...) always get kind of a quick feedback for an overview to see where actually are potential problems in the project.” *Interviewee 1*	An automatic overview with all project information, which can provide feedback to the users and the client without having to create an overview or report for this themselves.
”I would say the most, the biggest expectation was to get a report by, I would say one click. So, the data is in the background altogether, and you can make a just in time report every time you want to.” *Interviewee 8* ”especially for the data mining that in a kind of in the ideal case I would only have to click one button and then the report would kind of mine the data from the different applications.” *Interviewee 1*	Instead of having to create the report by obtaining the project data from all the different tools, there would be a possibility to generate a report of a project with one click on the button. This would be possible because the data is automatically collected together in the background.
”And my expectation was that all these different kind of tools, and all the different kind of information that we have, would get connected somehow. That we would have like one sphere, yeah, like one project environment for ourselves that we can work in, and see all our project information at one point.” *Interviewee 6*	That all the tools would be connected. And that there would be one platform on which work could be done and where all project information would be visible.
”So, OK, like, maybe even the time to prepare all this stuff would be shorter. Then, of course way easier usage and higher quality.” *Interviewee 2* ”I was really kind of anticipating this move because I really expected it to be helpful and making my work easier” *Interviewee 1*	It can be said that the overall expectation was to have the transition make the work easier. That this new process would help the employees with their daily jobs.

The interviewees mentioned that they expected the system to automatically create a project overview and a report, without having to go through all the different project documents manually. This would facilitate the work process and save time.

5.2.1.2.2 Experience with the transition process

Takes more time

It turns out that it takes quite some time to implement the new system. Problems were experience with setting up all the systems.

”And then we started, after the kickoff, where all the decisions were made, we started to put in all the data into the tools of course. One thing that took time” (Interviewee 4).

Mainly because all software tools used for the project need to be connected to the database, the implementation process takes time. The tools have to be prepared for use by allocating the right layout. Sometimes the software systems are not connected properly, causing technical problems, and solving these takes time (Interviewee 5). There are also other influences on the implementation time. The structure of the new system is well suited to single projects, but when implementing in a multi-project (one project consisting of several ’smaller’ projects), a lot of adjustments have to be made

(Interviewee 3).

It can be said that the implementation takes time because of the connections that have to be made to the central database. These connections are also more prone to errors. The implementation time also depends on the type of project, as the standardised structure of the system is more compatible with single projects.

Time to review working process

Despite that the transition process demands some time, this was also considered positive.

"So, for myself, the transition was then, of course, to rethink myself. Rethink all my internal thoughts about processes from my old world. With the old project to the new project with Digi PM." (Interviewee 6)

It provides an opportunity for employees to examine their current work process and improve it where possible. This will improve the working process and eventually the quality of the work.

Implementation moment

It is perceived that the moment when the integrated system is implemented in a project is important. The implementation during an ongoing project would result in a higher implementation time.

"we looked at all the established processes, and all the established reports that we had, and we came to the point that it would have taken such a big effort to recreate all these reports, and all these processes in order to make them Digi PM feasible." (Interviewee 6).

Here, it was tried to implement the new integrated system in an ongoing project. The processes and documents were already set up. Therefore, it would have taken a lot of time to adjust all the processes and transfer all project data into the systems with the right connection to the database. Because an ongoing project would require all project information to be transferred into the systems capable of communicating with the database. This implies that the implementation only is beneficial at the start of a new project.

Convincing users

During the transition process, challenges were experienced with convincing colleagues and clients.

"But I still think that it's pretty tough to get the colleagues to the point where they want to use the method. Because there are certain people who just believe in it, and there are others who don't." (Interviewee 7).

This appears to be due to different levels of belief in the new integrated system. The

reason is that people are used to the old way of working and are reluctant to deviate from it, for example due to lack of belief about the new system and its potential benefits (Interviewee 4). Another reason experienced is that older people may consider this change to more digital as difficult and therefore prefer to continue working in the old way (Interviewee 5). Consequently, the system may not be used to its full potential by all users, which causes that the transition will not have the desired result.

5.2.1.2.3 Experience of working with the new system

Result of standardisation

The software systems have to be able to communicate with the database, the system has a fixed structure and standard templates have to be used.

"change the templates or the Digi PM tool templates a little bit, for example in Ms project. (...) and all of a sudden the project doesn't give you the information that you want. (...) That isn't really that easy to handle, because it makes the work a little bit annoying." (Interviewee 4).

The structure of the standard templates cannot be changed easily because the connection to the database could be lost. The fixed structured forces the users to work in a particular way and sometimes adjust their own working methods (Interviewee 2). Consequently, employees are less flexible in adjusting their document structure according to their needs. The working pace of users may be delayed due to not being able to work as they used to before.

Nevertheless, standard templates are also seen as positive. In fact, it helps to ensure that all the data of a project is captured.

"you don't forget things because of this frameworks, you have for the data to drop in." (Interviewee 3).

Since there is a fixed structure for the standard templates, it is perceived that it helps remember to enter certain data. It can therefore be said that standardisation reduces the chances of losing certain data from a project.

The results show that there is also a challenge with standard templates with regard to adaptability. Not all projects are the same. Therefore, a template for reporting sometimes needs to be adapted.

"There are some reports set in the Power BI already, and you can say I use the Dreso report, and everything is fine, everything works perfectly. And, our client don't want this report. They wanted a little other way, and so we had to build our own Power BI." (Interviewee 3).

The experience shows that not all clients are satisfied with the standard templates prepared for reporting. It is important that there is the possibility of customising them

to the client's requirements (Interviewee 2). It can be argued that in a situation where the templates need to be customised to the client's requirements, this requires extra time. This delays the overall transition process.

Better project overview

It was claimed that the overall process for creating a project overview or report has been easier.

"And now, the Power BI report can combine all the details, and give you a better overview (...) you can combine more information. And the tool can do the work for you. Because before you had to use your brain to combine it, and now Digi PM can help you with that." Interviewee 4).

Here, the project overview is automatically created and displayed in a visualisation tool. This overview is interactive allowing the user to select the project information to be displayed. This facilitates the analysis of project information, since there is easier access to all project data (Interviewee 1). Furthermore, project reports can be created more easily because the integrated data from the database can be used. This implies time can be saved in this respect and due to the automation the risk of errors is reduced.

To enable this automation of the data collection, the project information in the various software systems must be up-to-date at all times. Only when all the data is present in the various data sources can the system provide a complete overview. This makes project team members feel more responsible for entering this information and therefore more involved in the project (Interviewee 8).

Need for support

Even though many tasks for creating a report for the client are automated, there are still manual tasks to be performed. However, often the project managers or leaders are not familiar with the technical background of the system (Interviewee 6). This results in a dependency on the digital manager.

"So, we try always to make the first two reports with the team, and then see if they can run on their own. Usually it's not the case, but still we try to push them in a direction" (Interviewee 9).

The aim is for everyone to be able to carry out all the steps of the digital process independently without needing support. However, in reality this turns out to be more difficult. As a result, the development of reports often requires support from the digital manager. At times, this is experienced as annoying as it may slow down the process (interviewee 8). As there are several people involved in creating the report, this is expected to slow down the process.

5.2.1.2.4 Experience of the learning process

The results of the interviews show that there are several approaches to the learning process.

"There was like a little academy offer. So, we had like a meeting with everyone in our team for two hours, they explained it to us, and then it was learning on the job," (Interviewee 8).

Training sessions on the different software systems can be attended. These training's are offered live, but also through the knowledge centre of the organisation (Interviewee 8). However, it appears that most of the participants learned to work with the systems by just starting to work with the systems (Interviewee 5). In addition, there are always people responsible for a type of system, which serve as a point of contact when users experience problems with that particular system (Interviewee 2).

The difficulty experienced in the transition to the integrated system can differ for each user.

"I think for some people it's harder than for others. I think it has something to do, like if you're more into like this technical things and if you have, like this thinking about data and how data works." (Interviewee 2).

If a user has little knowledge of the technical background of a system, it may be more difficult to recognise certain patterns. This can result in a longer period to become comfortable with the system. In addition, several interviewees indicated that a user's age can affect the difficulty experience (Interviewee 8). It is indicated that for the somewhat younger users it is probably not really a learning process because they are more familiar with the digital way of working. The results show that there is a perceived relationship with age and openness to change to an integrated system.

"And especially young people, who are very familiar with digital tools, should use it, (...) sometimes they are older, our clients, and they are like, oh digital can I not print it out." (Interviewee 8).

It is indicated by several participants that older colleagues or clients are less open to the transition to a more digital system. Often they are used to the old and would like to stick to the well-known. Whereas younger potential users are more open to digitisation because they are more familiar with it (Interviewee 6). Therefore, it can be said that during an transition process attention should be paid to enthuse the older colleagues and clients more enthusiast.

5.2.1.3. Important success factors

In order to be able to answer the sub-question regarding the important aspects of transitioning to a new project management system, the relevant code categories were reviewed. Out of these, relevant quotations were selected which contributed to formulating the important factors. These quotations with the corresponding important factor are presented in table 5.6. The table includes a concise explanation of how these

quotations were translated into the corresponding factor. The factors are included in the study if at least three interviewees consider them to be of importance. For each critical factor, the amount of interviewees is indicated by the number attached to the critical success factor.

It could be stated that support from an expert during the project is considered most important. It is said that the possibility of support probably made the transition more successful. This is followed by the importance of a well-designed structure set up and the will and motivation to go with the change. A good structure in the system is essential to maintain the connection with the database at all times. In addition, it is important to know what the objective of the use is so that the right tools can be used for that purpose. As final success factors that emerged from the results is acceptance and familiarity with the new system. To make the best use of the new system, it is important that all stakeholders accept this change.

Table 5.6: Success factors for successful transitioning from interviews

Statement interview	Explanation	Factor
”then also kind of the report with the information mining was set up by the, this colleague.” *Interviewee 1*	Not many end-users know about the technical level of the new system. Therefore, it is nice that the set-up of the project is done in cooperation with a Digi PM responsible/expert.	Support of expert (9x)
”There are some learning nuggets online. You can just look it up. So, if you have a very special question, you can just see a video or whatever. That was very easy,” *Interviewee 8*		
”that I also receive the support of the responsible team here in Frankfurt, otherwise it would be like, here you have the kind of different software solutions and now just go with it. I don’t think that it would have happened.” *Interviewee 1*	The idea that someone can fall back on a Digi PM responsible/expert at all times is reassuring. This will make a user consider the transition less of an obstacle, because they know there is support and they do not have to do it all on their own.	
”we have one responsible person from the Digi PM for our project, which we always can ask when something doesn’t work.” *Interviewee 3*		
”Have a good structure. Be consistent with naming stuff and doing your stuff.” *Interviewee 2*	Good set-up structure in the system and the words used. In order for this to result in a consistent way of working and thus making the most of the system. To avoid technical problems at a later stage, which can be demotivating. Besides that, the structure has to be set up properly in case to be able to connect to the database.	Setting up a good structure (6x)
”First of all, the basis, the foundation of Digi PM has to work. If there are always technical issues, that’s killing time and motivation. So that’s the beginning, and the concept has to be clear.” *Interviewee 7*		
”your data needs a good structure. For example, names. If you use names to connect data with each other from the different sources, and if you write the names different in every other source. They can’t connect to each other.” *Interviewee 2*		
”you have to make very clear for yourself, also in the beginning, what is exactly the thing I want to reach with Digi PM. What is the output I want to get.” *Interviewee 6*	Having a clear goal is important at the start of a project. In order to meet the client’s needs and requirements. And also to be able to be supported as best as possible by the system as a user.	
”I think it’s really important to have a clear mind about, what do you really need for the project? What does the client need?” *Interviewee 4*		

Continued on next page

Table 5.6 Continued from previous page

”Because we can do everything with the Digi PM, if we want to. But is it really necessary to use every tool in Digi PM, or is the client maybe so easy going, and doesn’t really want everything like that?” *Interviewee 4*	Many things are possible with the new system but not all options are needed for every project. This makes it important at the start of a project to determine which features will add value to the project and to the end users.	Setting up a good structure (6x)
”that was the first process, to decide what kind of things you want to do with Digi PM. And then to yeah, see how you want to implement it.” *Interviewee 6*		
”Like one main thing is willingness on the project site of course.” *Interviewee 7*	It is felt that it is very important that the end-users themselves are willing to undergo the change. Indeed, if they only need to be motivated from outside, it will not give optimal results.	Willingness / motivation (6x)
”First of all, the intrinsic will to do it, so that I wanted to do the transition.” *Interviewee 6*		
”the second most important thing, is probably the motivation, just in general from the project management team. To use this method, to believe in this method.” *Interviewee 7*	The project management team must be fully motivated to make the transition in their project.	
”I would say in general, it is a positive mind towards the process of Digi PM. I am convinced that the digital project management leads to an increase of efficiency, and it’s also an added value for our customers.” *Interviewee 8*	The end user must have a good feeling about the new system and tools. This can be created by him/her seeing the benefits. When this is so, the implementation will be easier because this person will be motivated.	
”it’s important that you teach somebody in the project like, OK, this is what you have to pay attention to in order for our database to understand.” *Interviewee 9*	Explaining how it works so that people understand how it works makes them more likely to work with the system. When someone does not know how it works, they are more likely to give up.	Making users familiar with the system (3x)
”the support, the training and explaining everything and also kind of explaining the advantages of the different solutions were crucial for me to kind of accept the process.” *Interviewee 1*	By sharing what the pros and cons of the new system are, potential users can better motivate themselves to go through the transition. Because they know what it can offer them.	
”At first, of course Drees & Sommer had a lot informational meetings for us. Where they talked about Digi PM, and what is it, is it smart for you to use it in your project and everything? And then we thought, OK, let’s let’s give it a try.” *Interviewee 4*		
”We also have the big, like knowledge platform for Drees & Sommer, where you can also, yeah, there’s some information about how to use COOR, and where you get all the contacts that are the power users for tools. So, you can can get in contact with them, and ask them questions.” *Interviewee 4*	Having a platform where users can find information helps familiarise users with the new system and tools. This platform includes training courses, guides and referrals to competence leaders. This prevents quick abandonment when problems arise because the user don’t know how to fix it.	
”Yeah, I mean, the people need to be open for new tools, of course.” *Interviewee 2*	It is important that users are open to start using the new system and tools. Otherwise, it will not be possible to implement these changes.	User acceptance (3x)
”I think one, one of the most important factors was that I was open and willing to do this process.” *Interviewee 1*		
”having the acceptance of the the clients. That they see that digitisation is good, and that they can profit from it. I think that’s a big part,” *Interviewee 5*	There are also things that change for the client, like for example the way of reporting. Therefore, it is important that they are involved in these changes. It is needed to include them in the process.	
”the acceptance from the client, and I think that was the biggest thing to get the check mark behind it. Showing him the new layout that he’s going to see in the reports, and dashboards that we use. And the underlying database, because some of the files that we had before that the client also got, did change.” *Interviewee 5*		

End of table

5.3. Chapter summary

The practical study aims to identify the transition from a fragmented to an integrated system. This involves considering the experience of system users and the factors important for a successful transition. Therefore, a preliminary survey and semi-structured interviews are conducted.

The interviews focus on identifying the differences between the old, fragmented system and the new, integrated system. To answer the sub-questions the interview was divided in three stages: before the transition, during the transition, and after the transition. This division enables a good comparison of the situation before and after, respectively fragmented and integrated. To analyse the results of the interviews a thematic analysis was conducted.

Answering sub-question, *"What are the differences between a fragmented and an integrated system in the context of transitioning to a digital project management system within a construction consultancy company?"*. The interviews show that the differences between working with a fragmented or an integrated system can be classified into four topics. These four topics are standardisation, connection of data, project overview, and reporting of a project. The main difference is that because of the connection between the data of the different sources in an integrated system more work can be automated. Therefore, the working process is simplified, the quality of the report increases, and the overall time will be reduced.

To answer sub-question, *"How is the transition from working fragmented to integrated experienced by the employees of a construction consultancy company?"*. It appears from the interviews that many of the users are positive about the transition to the integrated system. The expectation that it would save time has been partly fulfilled because the work can be more automated. However, the users of the system do partly depend on the digital manager. In addition, learning to work with the new system and implementing it at the beginning of a project does require more time compared to the old system. Despite this and the challenges experienced with adapting the standard templates to user and client needs, users are in general satisfied with the transition. The reason for this is that the overall work process has been made more convenient and the standardisation ensures that errors are reduced, and therefore the quality is improved.

Last, answering sub-question, *"What aspects are important to keep in mind when making the transition from a fragmented to an integrated digital project management system in a construction consultancy company?"*. How users think about the transition turns out to be an important factor for a successful transition. This user acceptance together with the will and motivation are of importance, and can be influenced positive by ensuring a well-designed structure of the system and by providing the end users with adequate information to familiarise them with the new system. Besides these factors, support from an expert is most important factor, according to the interviewees. They experience that this support makes people more confident about the system and working with it. As a result, the system is being used more effectively.

6

Discussion

This chapter discusses the findings of the study in relation to the research objectives, compared with the existing literature, interpreted in the theoretical perspective. The theoretical and practical implications, the limitations, and recommendations of the study are also addressed. A composition of the answers to the various sub-questions leading to an answer to the main question are presented at the end of this chapter in the diagram in figure 6.1. This figure also presents the contributions to the literature of this study. The diagram provides a summarising overview.

Several challenges and learning moments emerged during the research process, including the difficulties in obtaining limited access to relevance software systems and the change of research direction as result of the reflection moment at the end of research loop 1. Nevertheless, these challenges contributed a deeper understanding of the subject and led to an improvement in the research design, implementation, and transition process.

For this research, a literature review, software analysis, preliminary survey, and semi-structured interviews were performed. The semi-structured interviews are conducted among the three different type of users of the new integrated system; project managers, project leads, and digital managers (responsible for the implementation). The interviews were conducted until a status of saturation occurred. The interview protocol used was designed according to the sub-questions to ensure the right data was collected. The data obtained was analysed through thematic analysis.

To generate an answer to the sub-question, *"What are the differences between a fragmented and an integrated system in the context of transitioning to a digital project management system within a construction consultancy company?"*, a literature review and a software analysis were conducted. Additionally, semi-structured interviews were also carried out. The literature review revealed that the fragmented nature of the AEC industry results in inefficiencies. This can be due to the lack of technical support. This fragmentation is often accompanied by problems with interoperability of systems. This can cause loss of data when the data is shared. By implementing an integrated system, this problem can be reduced. Data is integrated into data environments, allowing better communication between data from different systems. It is mentioned

that for an integrated system, standardisation is very important. By implementing an integrated system, it will be possible to work more efficiently. This can reduce costs and time. During the analysis of the integrated project management system developed for Drees & Sommer, it became evident that the standardisation of the process and the documents is essential to be able to connect to the database, where all the project data comes together. It also showed that an integrated system requires more time at the start, because everything has to be set up and defined. However, the analysis does show that the integration enables more automation of work. As a result, time can be reduced. The interviewees provided insight into the transition process and the differences they experience between working with a fragmented or integrated system. This revealed that with the implementation of the integrated system, there has been more standardisation within the process. This standardisation is necessary to connect to the database in which the project data can be integrated. This standardisation contributes to simplifying the work process because new project documents do not have to be developed from scratch. It also creates a more uniform data set. The interviewees experience that this integrated approach ensures more automation in both the creation of a project overview and a report for the customer. It is no longer necessary to collect data manually from the various software systems, resulting in time reductions. In addition, these overviews and reports are interactive, allowing the user to easily view relevant data that contributes to a more complete picture of the progress of the project.

The findings of this study are aligned with previous studies that have shown that standardisation is important when implementing an integrated system (Haron et al., 2015). This standardisation is necessary to enable integration. This is because the use of a fixed structure and nomenclature is required to connect to the database. This research shows that this integration allows more work to be automated. It reduces the time required for these activities. In addition, both standardisation and automation contribute to improving the quality. It replaces human operations, which potentially eliminates errors in this process. This finding confirms the literature claiming that the probability of errors is reduced (Khanzode and Fisher, 2000). It can be added that standardisation and automation simplify and accelerate the work process for users. Less time is spent drafting new project documents because standard templates are available. In addition, project overviews are provided automatically, eliminating the extra time required to consult project data in the various software systems. These findings are consistent with previous research indicating that an integrated system saves time during a project (Kaner et al., 2008; Khanzode et al., 2008; Staub-French and Fischer, 2001). Although, this study adds that time savings only become apparent when an integrated system is used for a longer period. At the start of a new project, it is necessary to invest time to set up the connections to the system. As a result, the time benefits from work automation, for example, will only balance out when the project operates for a longer period. Provided the project duration is long enough, the findings of this study confirm that implementing an integrated system improves the overall efficiency of the project management process (Igwe et al., 2021).

How the transition to an integrated project management system is perceived leads

us to the sub-question, *"How is the transition from working fragmented to integrated experienced by the employees of a construction consultancy company?"*. A preliminary survey was conducted for this research question. Based on this survey, it can be said that 97% is positive about the transition to an integrated system. In addition, this topic was also addressed during the semi-structured interviews. These showed that it was expected that the transition to the integrated project management system would ensure that a connection could be made between the various software systems and that project data could therefore be collected in one place. Furthermore, the system was expected to simplify the work process and save time.

During the transition process the time saving does not appear to be experienced immediately. Starting a project with the integrated system now requires more time because connections have to be made with the database. In addition, the structure of the new system is not suitable for all projects, so it sometimes needs to be adapted. For this reason, it is sometimes difficult to convince colleagues and customers to go along with the transition to an integrated system. Despite the fact that the transition process takes time, the experience is that this extra time offers the opportunity to reflect on the old work process, in order to optimise.

Once the system can be used, it is experienced that the process is standardised. There are standard templates that facilitate the work. However, difficulties are experienced with these templates. If something in the setup is changed, there is a chance that the connection to the database will be lost. Therefore, the templates are not easy to adapt to the user's needs. This reduces the flexibility of the user working with the various systems. Nevertheless, this standardisation ensures that the data can be integrated, allowing the work to be more automated. This facilitates a better project overview. It also supports the creation of project reports for the client. The report can be created once, after which it is constantly updated with the most recent data from the database. To enable this, however, all data must be up-to-date. In the past, we experienced problems with data that was not entered on time. Because the system can only provide a complete overview when the data is up-to-date, the users feel more responsible and involved.

As the users often lack all technical knowledge of the system, they depend on the help of the digital managers. These digital managers therefore appear to be available at all times for support during the process. In addition, training's for the various software systems are also available. However, a majority of the participants indicated that they learned to work with the system through trial and error. How difficult they consider the system differs per person. This could have to do with the system technical background or age. Many participants indicate that they think younger people are more open to change and adopt change more easily than older colleagues. This because they are less used to the digital ways of working.

From these findings, it can therefore be concluded that the expectations have mostly been fulfilled. With the integrated system, all project data is collected and integrated on a central database. This requires standardisation, which is especially noticeable

for users due to the templates. Working with these templates is not perceived very positively because they are not easy to adapt, making the user less flexible. Also, the process is more error-prone, because when changing the setup, the connection to the database can be lost. Nevertheless, it can be said that these templates indirectly provide a positive experience and contribute to meeting the expectations. It contributes to automating parts of the process, making work easier and saving time. How soon a user can experience these benefits depends on how fast they master the system. It can be said that the learning process varies for each person because of the difference in technical background of the system. There appears to be a correlation between age and the pace of the learning process. It can be stated that younger users adopt the new system faster because they are more used to working in a digital way. Despite the different ways of learning the system, it can be said, based on the results, that most users learn to work with the system through trial and error. This is due to the fact that most systems are intuitive for users.

In order to answer the sub-question, *"What aspects are important to keep in mind when making the transition from a fragmented to an integrated digital project management system in a construction consultancy company?"*, a literature review was conducted. This literature study revealed 30 critical success factors that appear to be important for a successful transition of an integrated system. These factors are presented in table 6.1. For four factors, this research is in line with previous studies on the important factors for implementing an integrated system[1]. These factors are highlighted in the table.

Table 6.1: Critical Success Factors transition to integrated system

Critical Success Factors

User training	Top management	Project team quality	Project management
Monitoring and evaluation	Project goals, scope, etc	Change management	BIM awareness among end-users
Effectiveness of project leader	End-user involvement	External consultant	Business plan/vision/goals/justification
Communication	Knowledge sharing	National culture	Country-related functional requirements
Client acceptance	Implementation method/strategies	Vendor support	ERP solution
Data accuracy and integrity	User acceptance	Skilled staff	Employee/personnel relations
Open and honest communication	BIM policy	Productivity improvement	Regulatory environment
Budget for implementation	Project delivery methods	Organisational behavior	Organisational learning capability
Organisation size	Perceived industry pressure	Managing external project risk	Government support
Extend commission period and account for facility management	Human motivation, support, and consideration		

[1] (Awwad et al., 2022; Chatti et al., 2021; Çelikel, 2020; Naeem et al., 2017; Ngai et al., 2008; Somers and Nelson, 2001; Tambovcevs and Merkuryev, 2009; Ozorhon and Cinar, 2015)

All interview participants indicated that the involvement of a software expert is essential. It makes employees more open to the transition as they know they can always get help with issues. In addition, it is important that future users are well informed about the new system; how it works, the transition process, and its benefits. This allows optimal use of the system and employees are more likely to be open to the transition. This leads us to the factor of user acceptance. It is of great importance that the user accepts that a new system is being implemented. If the user is not willing to accept, the system may not be used effectively and the benefits may not be realised. To create this acceptance, it is important to get employees excited about the system. By sharing the benefits of the system, the user will be motivated to use it. Besides, it is important that the structure of the system is set up properly. By structure, this study means that the system should have a good foundation in order to operate in the best and most efficient way. The system should be well structured to allow connection to the database. For this structure to be established in the best possible way, it is important to clearly define the documents and processes according to the standardisation defined in section 2.1. This structure ensures cohesion between the database and standardisation in both the process and the documents. At the start of a new project, it is important that the workflow is explained clearly and that a good structure is set up in the project documents to minimise difficulties during the project. Standard templates for users should be made available by the organisation. These templates enable a connection to the database. The template for the users should already contain column names which establish the connection. It is important to provide the users, because when they have to create it themselves from scratch each time this will probably result in inefficient use of the system and losing the connection to the database. This is all necessary to ensure that the system can be used to its full potential and the users maintain their motivation. If a user experiences problems with the system, the motivation will slowly disappear. By ensuring the support and a good working system, a user is more likely to be satisfied with the system and remain motivated.

6.1. Implications

6.1.1. Theoretical implications

This study provides analytical evidence for a number of benefits of implementing an integrated system that are identified in the literature. It was found that by integration, the problem with the lack of interoperability is solved by connecting the different data sources to the central data base. Due to the fact that all project data is collected and integrated on this central data base, the project data from the different data sources can be connected and presented as one. In addition, this research adds that the time savings are primarily due to the ability to automate activities. This allows manual work to be replaced which ensures that these activities require less time. According to this study, the benefits in relation to time savings are only apparent after a longer period of time. This is because starting a project in the integrated system takes more time. After this transition period, the time benefits will become apparent and the work process will be more efficient.

Besides confirming the critical success factors from earlier study (table 6.1), this study

also contributes to the literature by adding a success factor. This is the success factor 'Setting up a good structure'. It stands for creating a good structure of the system during the implementation. This structure is key to ensure the system works smoothly. By minimising the potential for errors in the system, there is less chance of users losing motivation.

6.1.2. Practical implications

This research is relevant for construction companies that want to make a transition from a fragmented to an integrated project management system. It provides companies with insight into their employees' potential response to the transition, and what is considered important. In this process, they should consider the importance of the acceptance and motivation of the end users of the system. By providing end users with comprehensive information about the system and the transition procedure, they know what to expect. In addition, by sharing what the system can provide the user, they will be more likely to accept the system and motivate themselves to engage in the transition. This increases the likelihood of a successful transition, allowing work to be carried out more efficiently and faster.

6.2. Limitations and Recommendations

The first limitation of the study concerns the preliminary survey. No quantitative evidence can be derived from this survey because the respondents were not familiar with the project management system to be implemented. There was no clear understanding of the system and the transition process among the respondents. As a result, it was not feasible to give an informed answer as to whether they were open to the new system. It is therefore recommended to conduct a survey among employees who are not yet using the system. This survey should provide a good explanation of the system and the transition process in order to enable respondents to indicate whether they are open to the transition.

The next limitation of this study is the fact that the interviewees of this study are from one organisation and country. This implies that outcomes may differ in other contexts. Therefore, a future study that investigates the contextualisation of the transition to an integrated project management system is recommended. In addition, these interviewees have an age between 24 and 35 years old. For this reason, no general statement can be made on whether the age of a user affects the acceptance of change and the learning process. Therefore, a future study is recommended in which the interviews be conducted with users of the integrated system where the age is more distributed. Consider ages between 24 and 67. The limit is set at 67 because this is the retirement age in the Netherlands. In case the research is done outside the Netherlands, this age can be adjusted to the retirement age of the research location.

In addition, the transition to the integrated project management system of this case study is not entirely finished. The system is being implemented in an increasing number of projects resulting in differences in the duration of the experience of the users with the system. Consequently, the shared experiences often include the transition

process. This experience might differ when working with the system for a longer period of time. It is advised to conduct a future study in which the integrated system is completely implemented for a number of years to determine whether the experience of the transition is similar to the experience found in this study.

The last limitation of this study concerns the selection of interviewees. The interviews were conducted among users and stakeholders within the organisation. However, it emerged during the interviews that the transition process towards an integrated system also affects the clients. As the clients were not included in the interviews, no further statements can be made about how this transition is experienced by the clients. In order to be able to draw conclusions on this matter, further research into the experience of the transition to an integrated system can have on the organisation's clients is recommended.

6.3. Recommendations for practice

For organisations considering the transition to an integrated digital project management system, this research can be used to inform on what is required for both the employees as their organisation. This will help them to decide whether they consider the system worth the investment. As more insight has been generated into what actions need to be executed to get the benefits of an integrated system.

During the transition process, the organisation should ensure adequate communication with the end user about the system and the process. To enable integration, the process needs to be standardised. However, the fact that all projects differ from each other should be taken into account when developing this standardisation. As a result, there should be a possibility to adapt the standard templates to a project's requirements. Before the benefits of implementing the integrated system are apparent, time should be invested by the users and digital manager to ensure that everything is set up properly and the users are familiar with the system. This is important to ensure that the minimum number of problems are experienced with the system, which will maintain user motivation. Furthermore, the study shows that the implementation of the new system is profitable only if it is performed at the start of a new project. In addition, it is important to ensure that the end users accept the transition. It is therefore recommended to familiarise these users with the benefits of the system, motivating them to start using the system. It is also recommended to assign an expert about the system to serve as a contact person, in order to help the end users when problems arise.

The findings of this study contribute to the literature by providing analytical evidence of the positive effects of an integrated system. In addition, it adds a critical note regarding the time investment required during the transition period. Furthermore, it presents aspects that practitioners should consider to ensure that the implementation of the new integrated system is as successful as possible.

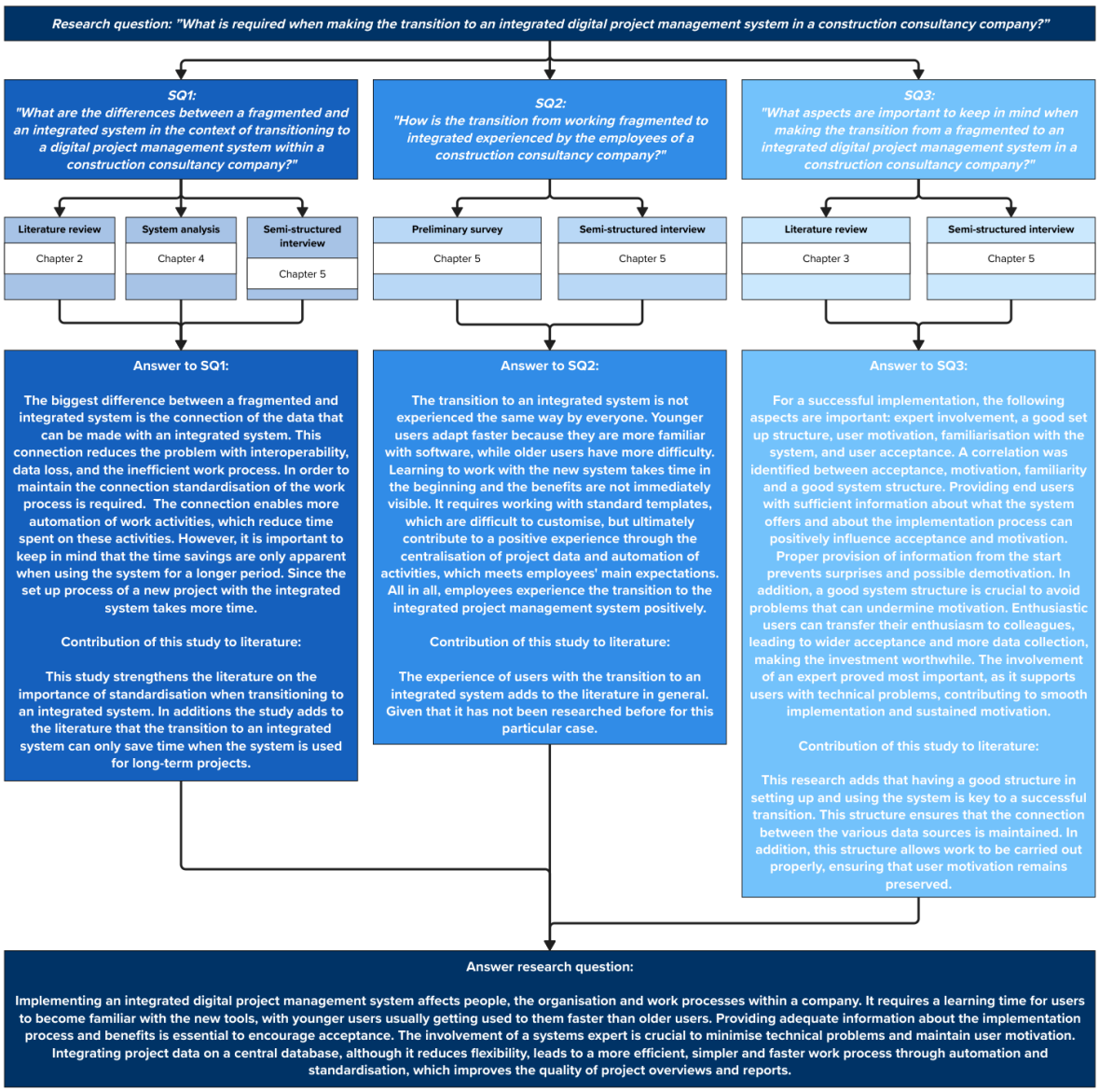


Figure 6.1: Diagram of composition of research answers

7

Conclusion

This study will provide an answer to the research question: *"What is required when making the transition to an integrated digital project management system in a construction consultancy company?"*. The aim is to offer analytical evidence on what is required to obtain the benefits when transitioning to an integrated software system to support project management in a construction consultancy company. In order to answer this question and provide analytical evidence, three sub-questions have been drawn up. The first section answers these three sub-questions. These answers provide more thorough justification and reinforcement to the main conclusion, which is answered in the second section.

7.1. Sub-question conclusions

The first research question, *"What are the differences between a fragmented and an integrated system in the context of transitioning to a digital project management system within a construction consultancy company?"*, presents the differences between working with a fragmented or integrated project management system. To answer this question, literature research was performed and semi-structured interviews addressed this subject. In the fragmented project management system, no connection can be made between the project data from the different software systems; these systems are not interoperable. As a result, if data is shared between different systems, data might get lost. One of the biggest difference with the integrated system is the central data base where all project data from the different software systems is collected and integrated. This enables the data from the different systems to be merged together, eliminating the problem of interoperability of systems and the loss off data. In order to integrate the project data from the different systems, it is necessary to standardise. This standardisation is required to ensure the data from the different sources can be connected to each other in the central database. This standardisation provides a more structured and efficient work process. In addition, it can be concluded from this research that with an integrated system there is a greater possibility of automating activities. This is due to the fact that data is centralised and connected. This simplifies these activities and saves time. Since manual tasks are replaced. Furthermore, the quality of the activities improves because the human factors are eliminated. This prevents the minor human errors. To answer the sub-question, it can therefore be concluded that the difference

between a fragmented and an integrated system is the fact that with an integrated system, a connection can be made between the data from the different sources. This connection allows activities to be automated which contributes to an increase in quality, provides assistance to users, and a reduction in time for these activities. However, this time reduction may only become apparent after a longer period of time. This is due to the extra time required at the start of a project to set up the software systems in order for the data to be linked to the project and to be communicated to the central database where this data is integrated.

To investigate the human aspect of the transition, semi-structured interviews were conducted. In order to answer the sub-question, *"How is the transition from working fragmented to integrated experienced by the employees of a construction consultancy company?"*. This researched reveals that the transition is not experienced the same by everyone. Not all people are open to the new integrated system because they prefer to remain with the way things were. According to this study, this is related to user motivation, which appears to have a correlation with the age of the user. When a user is younger, they are most likely to be familiar with software systems and therefore adopt it more easily. As a result, they will be more open to the change than older people who have more difficulty learning a new system. Learning to work with the new system requires a time investment at the beginning, meaning that the benefits of the system are not immediately apparent. Before a user has mastered the system, activities will take more time. Not until they work with the system for a longer period will the benefits of the system be apparent. This is in line with the use of the standard templates needed to connect to the database. These templates are not easy to adapt to the needs of the user because the connection may be lost, reducing the flexibility of employees to customise. As a result, they may have to adjust their current work process. This adaptation and getting used to this process requires time. However, these standard templates still indirectly contribute to a positive experience with the new system. After all, they contribute to enabling the collection of all project data on a central database, allowing the data to be integrated. This results in more automation of activities, making activities easier and requiring less time. This fulfilled the most important expectations of the employees, leading to the conclusion that their experience with the transition to an integrated project management system is positive.

The semi-structured interviews conducted among the end-users of the system was also established to answer sub-question, *"What aspects are important to keep in mind when making the transition from a fragmented to an integrated digital project management system in a construction consultancy company?"*. This resulted in the following aspects that are important to ensure a successful transition: involvement of an software expert, good system structure, motivation of end-users, familiarisation with system, and acceptance of the system by the end-users. A relation was identified between user acceptance, motivation, familiarisation with the system, and setting up a good structure. It can be concluded that by providing end-users with adequate information about what the system can offer and the process involved with the transition, this can affect the acceptance and motivation. This should therefore be positively stimulated by sharing the benefits of the system. By properly informing employees at the

start about the system, the transition process, and the benefits, it enables the employees to consider whether it is worth the effort. As a result, they will avoid surprises that could potentially lead to demotivation and rejection towards the system. In addition, it can demotivate the end-user if they experience problems with the system. Therefore, it is important to have a good system structure. The study emphasises the need for a solid system structure for optimal efficiency. This structure should facilitate database connectivity and be well-defined according to the standardisation defined in this study (section 2.1). Clear documentation and processes are crucial for cohesion between the database and standards. At the start of a project, a well-organized workflow and project documentation should be established to avoid difficulties. The organization should provide standard templates to prevent inefficiencies and connection issues. This ensures that the system is fully utilised and that users remain motivated. The study concludes that if users of the system are enthusiast, they can share this enthusiasm with their colleagues. By conveying this to others, more employees would want to work with the system, making the benefits of the system increasingly evident. More data will be collected in the database, allowing for a more complete overview of a project. This will increasingly make the investment worthwhile. The factor that proved most important according to this study is the involvement of an expert. This involvement provides users with support in the process since they often lack technical knowledge about the system, thus contributing to a smooth transition. If there is no support during the first phase of using the integrated system, there may be technical problems that the user cannot easily solve on their own. This can negatively affect the motivation of the user. By assigning an expert on the system to a project, problems are solved more quickly and easily, ensuring that the user remains motivated.

7.2. Main conclusion

Based on the findings of this study, it can be argued that the transition to an integrated digital project management system requires different things from the people, the organisation, and the work process within a company. For the users of the new system, the current work process changes and they have to work with new tools. This period of implementing the system for new projects and the learning process of the users requires time. It can be concluded that the period of time to learn the new system and tools varies per person. This can depend on the system technical background of a user or their age. When a user is younger, they will be more familiar with digitisation, making it easier to adopt. For older users, this may require a more time because they are less familiar with it. This is one of the reasons why older employees are less open to the change to an integrated project management system. To ensure that these users still accept the transition, this study shows that it is very important to properly inform the user about the transition process and the benefits of the system. This allows them to consider whether the time investment is worth the effort. In addition, the company should ensure proper organisation in the supervision of the implementation and use of the system by a system expert. With the support of this expert, fewer technical errors will occur, making the user less likely to lose motivation.

The transition to the integrated system results in all project information being collected and integrated on a central data base. To enable this integration, the process needs to

be more standardised. This study defined standardisation, in the context of implementing an integrated digital project management system, as the process of establishing uniform procedures, protocols and formats for various aspects of project management. By using standard processes and templates, a connection can be made between the sources and the central database. In this central database, the project data is integrated. Standardisation will reduce the flexibility of the work process for users, but is essential for the connection and integration of the data. This integration ensures a more effective, easier, and faster working process. This research concludes that these benefits are due to the automation of work enabled by integration. This automation replaces the time-consuming activity of collecting all project data from the various project management systems to create an overview or a project report. It also contributes to improving the quality of these overviews and reports by avoiding human errors.

Therefore, it can be concluded that the work efficiency and quality of the project overview and reports is increased when the project documents and process is standardised as part of creating a proper structure. After investing time at the start of project for learning to work with the system and for the creation of the connections between the systems, time is saved during the project management process.

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A

Critical Success Factors from literature

This appendix contains the table (A.1) with the various critical success factors that, according to the referenced literature, influence the implementation of a new digital project management tool. The table starts on the next page.

Table A.1: Critical Success Factors from literature

Dimension	ID	Critical Success Factors	Explanation	Perspective	Sources
Human	C1	User training	Basic education/training on system operation	Construction industry implementation	(Chatti et al., 2021) (Tambovcevs and Merkuryev, 2009) (Almutairi, 2023) (Al-Amin et al., 2023) (Ngai et al., 2008) (Somers and Nelson, 2001) (Chausi et al., 2016) (Reitsma and Hilletofth, 2018) (Ozorhon and Cinar, 2015) (Yogesha, 2020) (Ghostin, 2020) (Awwad et al., 2022)
	C2	Top management	Positive commitment, enthusiastic about the project and strong support	Construction industry implementation	(Chatti et al., 2021) (Tambovcevs and Merkuryev, 2009) (Almutairi, 2023) (Al-Amin et al., 2023) (Ngai et al., 2008) (Naeem et al., 2017) (Somers and Nelson, 2001) (Chausi et al., 2016) (Gavali and Halder, 2020) (Ozorhon and Cinar, 2015) (Mohd Asfahani, 2020) (Çelikel, 2020) (Ghostin, 2020) (Awwad et al., 2022)
	C3	Communication	Clear and effective communication at all levels of an organization	General ERP implementation	(Ngai et al., 2008) (Naeem et al., 2017) (Reitsma and Hilletofth, 2018) (Yogesha, 2020) (Awwad et al., 2022)
	C4	Skilled staff	The staff has clear understanding of the project mission and vision	General ERP implementation	(Al-Amin et al., 2023) (Naeem et al., 2017) (Çelikel, 2020)
	C5	Employee/personnel relations	Good relations between employees and with management	General ERP implementation	(Ngai et al., 2008)
	C6	Open and honest communication	Room for honest communication and feedback	General ERP implementation	(Ngai et al., 2008)
	C7	Effectiveness of project leader	Overcoming problems is important. Effective project leaders can help resolve conflicts or communication problems between employees.	Construction industry implementation	(Ozorhon and Cinar, 2015)

Continued on next page

Table A.1 Continued from previous page

Dimension	ID	Critical Success Factors	Explanation	Perspective	Sources
Human & Organisational	C8	Project team quality	Balanced team, to meet technical and business requirements of the project. Competences of the team and teamwork	Construction industry implementation	(Chatti et al., 2021) (Tambovcevs and Merkuryev, 2009) (Ngai et al., 2008) (Somers and Nelson, 2001) (Chausi et al., 2016) (Reitsma and Hilletofth, 2018) (Gavali and Halder, 2020) (Ozorhon and Cinar, 2015) (Yogesha, 2020) (Ghostin, 2020) (Awwad et al., 2022)
	C9	Project management	According to the project goals, determining project plan, allocating resources, and controlling cost and budget	Construction industry implementation	(Tambovcevs and Merkuryev, 2009) (Almutairi, 2023) (Ngai et al., 2008) (Naeem et al., 2017) (Somers and Nelson, 2001) (Reitsma and Hilletofth, 2018) (Yogesha, 2020) (Awwad et al., 2022)
	C10	Interdepartmental communication	Communication is essential within the project team, between the team and the rest of the organization	General ERP implementation	(Almutairi, 2023) (Ngai et al., 2008) (Somers and Nelson, 2001)
	C11	Project champion	Understand both the technology as well as the business and organizational context	General ERP implementation	(Ngai et al., 2008) (Somers and Nelson, 2001) (Yogesha, 2020)
	C12	Interdepartmental cooperation	Common goals and coordination of efforts and goals between different parties	General ERP implementation	(Ngai et al., 2008) (Somers and Nelson, 2001) (Çelikel, 2020) (Ghostin, 2020)
	C13	Human motivation, support and consideration		ERP implementation in developing country	(Naeem et al., 2017)
	C14	National culture	Basic values, beliefs and norms in different countries will affect organizational culture, and in turn, the practices of professional activities, including implementation	ERP implementation in Europe	(Ngai et al., 2008)
	C15	Country-related functional requirements		ERP implementation in Europe	(Ngai et al., 2008) (Ghostin, 2020)
	C16	Client acceptance		ERP implementation in Europe	(Ngai et al., 2008)
	C17	User acceptance		Integrating IT applications	(Chatti et al., 2021)
	C18	End-user involvement	Involve the user of system during the implementation	Construction industry implementation	(Ozorhon and Cinar, 2015)

Continued on next page

Table A.1 Continued from previous page

Dimension	ID	Critical Success Factors	Explanation	Perspective	Sources
Human & Organisational	C19	Monitoring and evaluation	Performance can be monitored and evaluated by getting user feedback to make sure whether it is heading to realize the business objectives	Construction industry implementation	(Tambovcevs and Merkuryev, 2009) (Al-Amin et al., 2023) (Ngai et al., 2008) (Naeem et al., 2017) (Chausi et al., 2016) (Yogesha, 2020)
	C20	BIM awareness among end-users		Construction industry implementation	(Chatti et al., 2021) (Ozorhon and Cinar, 2015) (Mohd Asfahani, 2020) (Çelikel, 2020) (Ghostin, 2020) (Awwad et al., 2022)
	C21	Knowledge sharing		Construction industry implementation	(Çelikel, 2020) (Awwad et al., 2022)
Organisational	C22	Project goals and scope etc.	Project should begin with a conceptualization of the goals and possible ways to accomplish these goals	Construction industry implementation	(Tambovcevs and Merkuryev, 2009) (Ngai et al., 2008) (Naeem et al., 2017) (Somers and Nelson, 2001) (Chausi et al., 2016) (Ozorhon and Cinar, 2015) (Yogesha, 2020) (Ghostin, 2020)
	C23	Business process re-engineering	Business processes are aligned with the system	General ERP implementation	(Chatti et al., 2021) (Ngai et al., 2008) (Somers and Nelson, 2001) (Chausi et al., 2016) (Reitsma and Hilletofth, 2018)
	C24	Change management	Balancing of forces in favour of a change over forces of resistance	Construction industry implementation	(Tambovcevs and Merkuryev, 2009) (Ngai et al., 2008) (Naeem et al., 2017) (Somers and Nelson, 2001) (Chausi et al., 2016) (Ozorhon and Cinar, 2015) (Yogesha, 2020) (Awwad et al., 2022)
	C25	Management of expectations		ERP implementation in Europe	(Ngai et al., 2008) (Naeem et al., 2017) (Somers and Nelson, 2001) (Reitsma and Hilletofth, 2018)
	C26	External consultant	Use knowledge and expertise of consultant of the system	Construction industry implementation	(Tambovcevs and Merkuryev, 2009) (Ngai et al., 2008) (Somers and Nelson, 2001) (Ozorhon and Cinar, 2015) (Awwad et al., 2022)

Continued on next page

Table A.1 Continued from previous page

Dimension	ID	Critical Success Factors	Explanation	Perspective	Sources
Organisational	C27	Business plan/vision/ goals/justification	Business plan and vision should define how the organization operates behind the implementation effort	Construction industry implementation	(Ngai et al., 2008) (Naeem et al., 2017) (Reitsma and Hilletofth, 2018) (Gavali and Halder, 2020) (Yogesha, 2020) (Awwad et al., 2022)
	C28	Implementation methods/ strategies	Managers should decide whether the organization is willing to change its business flow to fit the software, or whether it prefers to change the software to fit the business flow	Construction industry implementation	(Tambovcevs and Merkuryev, 2009) (Ngai et al., 2008)
	C29	Vendor support	The selection of a suitable ERP vendor is very important, as a good vendor can provide support ranging from technical assistance to training	Construction industry implementation	(Ngai et al., 2008) (Somers and Nelson, 2001) (Ozorhon and Cinar, 2015)
	C30	Deciding on the implementation approach	Software development, configuration, testing and troubleshooting	General ERP implementation	(Chausi et al., 2016)
	C31	Appropriate business and IT legacy systems	Be aware of the old system still in use, to prevent from various errors in data conversion and analysis	ERP implementation in Europe	(Ngai et al., 2008) (Chausi et al., 2016) (Gavali and Halder, 2020)
	C32	Education on new business processes	Communicate new goals and long-term perspectives in order to win support of all members of the organization affected by the changes	General ERP implementation	(Somers and Nelson, 2001)
	C33	Use of steering committee	Form a steering committee or group of “superusers”	General ERP implementation	(Somers and Nelson, 2001)
	C34	Well defined controlled budget for ERP implementation		ERP implementation in developing country	(Naeem et al., 2017)
	C35	Good crisis management and ability to handle surprises		ERP implementation in developing country	(Naeem et al., 2017)
	C36	Progressive corporate culture and work climate	Sharing common goals in relation to individual activities and the value of trust between partners, employees, managers and businesses	ERP implementation in developing country	(Naeem et al., 2017) (Yogesha, 2020) (Çelikel, 2020)
	C37	Aligned business process		ERP implementation in developing country	(Naeem et al., 2017)
	C38	Managing conflicts in ERP projects		ERP implementation in Europe	(Ngai et al., 2008)
	C39	Clear and simple project organization		ERP implementation in Europe	(Ngai et al., 2008)
	C40	Organizational characteristics	Characteristics of an organization have a significant influence on the success of the implementation	ERP implementation in Europe	(Ngai et al., 2008)
	C41	Bench-marked implementation progress against clear milestones or performance metrics		ERP implementation in Europe	(Ngai et al., 2008)
	C42	Staff retention	Keeping the same staff will safe time of teaching new people the system	ERP implementation in Europe	(Ngai et al., 2008)
	C43	Full-time team members	Having employees working full time on the implementation	ERP implementation in Europe	(Ngai et al., 2008)

Continued on next page

Table A.1 Continued from previous page

Dimension	ID	Critical Success Factors	Explanation	Perspective	Sources
Organisational	C44	BIM policy		Construction industry implementation	(Yogesha, 2020) (Çelikel, 2020) (Awwad et al., 2022)
	C45	Productivity improvement		Construction industry implementation	(Yogesha, 2020)
	C46	Regulatory environment		Construction industry implementation	(Yogesha, 2020) (Mohd Asfahani, 2020)
	C47	Budget for BIM implementation		Construction industry implementation	(Yogesha, 2020) (Mohd Asfahani, 2020) (Çelikel, 2020)
	C48	Project delivery methods that address BIM		Construction industry implementation	(Yogesha, 2020)
	C49	Organisational behavior		Construction industry implementation	(Yogesha, 2020)
	C50	Organizational learning capability		Construction industry implementation	(Yogesha, 2020)
	C51	Size of organisation		Construction industry implementation	(Mohd Asfahani, 2020)
	C52	Perceived industry pressure		Construction industry implementation	(Mohd Asfahani, 2020)
	C53	Managing external project risk		Construction industry implementation	(Ghostin, 2020)
	C54	Extend commission period and account for facility management		Construction industry implementation	(Ghostin, 2020)
	C55	Government support		Construction industry implementation	(Awwad et al., 2022)
Organisational & Technical	C56	Project complexity		Construction industry implementation	(Mohd Asfahani, 2020)
	C57	Project size		Construction industry implementation	(Çelikel, 2020)
	C58	Kept suppliers/customers informed		ERP implementation in Europe	(Ngai et al., 2008)
	C59	Startup and testing the system	To motivate the end-users and detect potential problems in a timely manner	Construction industry implementation	(Ozorhon and Cinar, 2015)
Technical	C60	Data accuracy and integrity	Since ERP contains various modules that are intricately linked with each other, data should be managed properly to ensure their accuracy.	Construction industry implementation	(Tambovcevs and Merkuryev, 2009) (Almutairi, 2023) (Ngai et al., 2008) (Chausi et al., 2016) (Mohd Asfahani, 2020)
	C61	ERP solution	A company should select an ERP package that fits the business practices and processes of an organization	Construction industry implementation	(Chatti et al., 2021) (Ngai et al., 2008) (Somers and Nelson, 2001) (Gavali and Halder, 2020) (Ozorhon and Cinar, 2015)

Continued on next page

Table A.1 Continued from previous page

Dimension	ID	Critical Success Factors	Explanation	Perspective	Sources
Technical	C62	IT infrastructure	IT infrastructure has effect to the long-term vision and strategy of the enterprise	ERP implementation in Europe	(Al-Amin et al., 2023) (Ngai et al., 2008) (Naeem et al., 2017)
	C63	Data analysis and conversion	Being able to enter the data in the new system	ERP implementation in Europe	(Ngai et al., 2008) (Somers and Nelson, 2001)
	C64	Minimal customisation	Involves using the vendor's code as much as possible even if this means sacrificing functionality	ERP implementation, user perspective	(Somers and Nelson, 2001) (Reitsma and Hilletofth, 2018)
	C65	Architecture choices	Development of the system related to centralization or decentralization, compatibility of existing tools within the enterprise with the ERP system	General ERP implementation	(Somers and Nelson, 2001)
	C66	Dedicated resources	Resource requirements need to be determined early in the project and often exceed initial estimates	General ERP implementation	(Somers and Nelson, 2001)
	C67	Software configuration		ERP implementation in Europe	(Ngai et al., 2008)
	C68	Technical possibilities in company		Construction industry implementation	(Mohd Asfahani, 2020) (Çelikel, 2020) (Awwad et al., 2022)
	C69	Software compatibility		Construction industry implementation	(Mohd Asfahani, 2020) (Awwad et al., 2022)
	C70	Troubleshooting	Testing and troubleshooting of the ERP system is necessary to ensure that the software functions according to plan. Troubleshooting for errors is particularly critical	Construction industry implementation	(Ngai et al., 2008) (Gavali and Halder, 2020)

End of table

B

Preliminary survey Drees & Sommer Netherlands

This chapter contains the comprehensive result of the preliminary survey. The methodology is discussed followed by the more detailed findings. Finally, the survey questions and the report of results are presented.

B.1. Methodology

The survey conducted is a cross-sectional survey research because the goal of the survey is collecting insights from the project managers (target audience) at a particular time interval (Bhaskaran, 2024). This particular time interval is the period before the new integrated digital project management tool was implemented. It is an online survey shared via e-mail with the project managers. The project managers were chosen as they will be the end users of the new integrated project management tool. The choice of the Dutch location has to do with the fact that the new tool has not yet been implemented there.

The study was carried out among the population size of 30 project managers within the Dutch organisation. The sample size is 29 project managers. This ensures that with a margin of error of 3%, the survey has a confidence level of 95% (Good, 2023). It was more important to understand the use of the software systems, project management documents and attitudes towards the transition than knowing the details. As a result, the survey was mainly composed of multiple-choice questions. The questions in the survey cover the software systems used, the project documents used and their standardisation. It also addressed how project documents are shared. Finally, the transition to a more integrated work process was considered.

From the literature review in section 2.2, CSFs have been addressed that are found to be of great importance in the implementation of new software systems. Eleven of these CSFs from table 2.1, relating to human aspects, were presented to the respondents. Hereby, they had to indicate which of the factors that are of great influence for them in an implementation. For the 11 CSFs presented, please refer to section B.4, page 25 of the document. In appendix section B.3 the whole questionnaire can be

seen.

B.2. Results

The survey shows that the various Microsoft Office software systems are mainly used for project management work. For the documents worked on in these systems, there appear to be only 34% standardised documents on average. Of these standardised documents, 45% of project managers know where to find these documents.

Different types of systems are used for sharing and storing the project documents. This may be related to the difficulty experienced in making connections between different documents. Possibly because of this, 97% of the respondents are willing to invest time in the transition. Respondents expect to work more efficiently after the transition, to create a better overview of the project documents and to standardise the process more.

The results showed that User training is seen as the most important CSF by most respondents. After that User acceptance, Clear and effective communication, Project team quality, and End-user involvement come a shared second.

B.3. Survey questionnaire

The document referred to in this section contains the questionnaire presented to the respondents, project managers of the Dutch office of Drees & Sommer. For document with the survey results you are referred to the next page.

ENG-Current digital pm situation Drees & Sommer

Start of Block: Introduction

Q0 Dear participant,

You are being invited to participate in a research study titled “Moving towards digital project management - Implementation of a new digital project management tool in a Dutch consultancy company”. This graduation research is conducted by Kim Baars for the completion of her master's degree in Construction Management and Engineering at Delft University of Technology in collaboration with Drees & Sommer Netherlands.

The purpose of this research study is to fill gaps in literature studying the digital project management tool implementation in a consultancy and project management company in the Netherlands. In addition, the new knowledge will be used to advise on the implementation of a new digital project management tool and for which pilot projects the use is suitable.

There are many possibilities with BIM tools, but they are insufficiently implemented due to the challenges and risks involved. One of the risks often highlighted in research is that digital tools are not interoperable with each other. As a result, a lot of knowledge may get lost and the tools are not used to their full potential. This is partly because there is no clear guidance on how the new digital tools can best be implemented. Besides interoperability, there are also other factors that influence implementation. There are several studies investigating and determining these Critical Success Factors (CSFs). However, these studies mainly focus on the implementation of a new tool one specific country. There are no studies dealing with the implementation of a new tool adopted by a Dutch organisation from Germany. Therefore, this study will focus on these issues.

For this study, one of the activities that will be carried out is conducting a survey. Your participation will take you approximately 5-10 minutes to complete. The data will be used for identifying the use of current software systems and the cooperation between them. Based on this, the final advice will be created. This will be used in the final thesis document. During the survey you will be asked to answer both open and closed questions.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by conducting the survey in a secure online environment. The non-anonymised data and results from the survey will be stored in separate folders on my personal TU Delft OneDrive and will be deleted as soon as possible. These will not be made public as they are not part of my thesis. The results will be anonymised and used in the thesis report.

Your participation in this study is entirely voluntary and you can withdraw at any time. By clicking through to the online survey, you agree to this opening statement.

I would like to thank you for your cooperation and time.

Contact details of the executive and responsible researcher:
Kim Baars (+31 6 54983119)
kim.baars@dreso.com or k.baars-1@student.tudelft.nl

End of Block: Introduction

Start of Block: General questions

Q1 What is your age?

	0 10 20 30 40 50 60 70 80 90 100
My age: (1)	

Q2 What is your function within Drees & Sommer?

_____

Q3 How long have you been working within Drees & Sommer?

- ☐ 0 - 1 year (1)
- ☐ 1 - 3 years (2)
- ☐ 3 - 5 years (3)
- ☐ 5+ years (4)

End of Block: General questions

Start of Block: Current tools in use

Q4 What software systems/apps do you use when performing project management activities?
Please select from the list below and explain what activities you use them for.
You can select multiple systems/apps.

- ☐ AutoCAD, used for: (1) _____
- ☐ COOR, used for: (2) _____
- ☐ Excel (Microsoft), used for: (3) _____
- ☐ Navisworks, used for: (4) _____
- ☐ Onedrive (Microsoft), used for: (5) _____
- ☐ Power BI (Microsoft), used for: (6) _____
- ☐ Project (Microsoft), used for: (7) _____
- ☐ Revit, used for: (8) _____
- ☐ Sharepoint (Microsoft), used for: (9) _____
- ☐ Teams (Microsoft), used for: (10) _____
- ☐ Word (Microsoft), used for: (11) _____
- ☐ Other, namely: (12) _____

Page Break

Q5 Select which of the following documents you use in your project management work during the start/initiation of a project.

- [ ] Action plan (execution and project) (1)
- [ ] Construction process diagram (2)
- [ ] External project start-up (3)
- [ ] Feasibility investigation (4)
- [ ] Internal project start-up (5)
- [ ] Interview document (6)
- [ ] Organisation charts (7)

Page Break

Q6 Select which of the following documents you use in your project management work regarding contracts?

- [ ] AO (Building Contract/Construction Agreement) (2)
- [ ] Demarcation (9)
- [ ] LOI (Letter of Intent) (3)
- [ ] PoR (Programme of Requirements) (4)
- [ ] Scope of work (1)
- [ ] Specifications of project (8)
- [ ] SPA (Sales and Purchase Agreement) (5)
- [ ] TO (Technical Description) (6)
- [ ] UPD checklist (Exit Points Document) (7)

Page Break

Q7 Select which of the schemes you use in your project management work.

- [ ] Communication scheme (1)
- [ ] Construction site layout (2)
- [ ] Consultation structures scheme (3)
- [ ] Drawing rotation scheme (4)
- [ ] Procurement scheme (5)

Page Break

Q8 Select which of the following documents you use in your project management work regarding project control.

- [ ] Action decisions list (1)
- [ ] Agenda (construction) meeting (2)
- [ ] Minutes (construction) meeting (3)
- [ ] Status update form (4)
- [ ] To Do list (5)

Page Break

Q9 Select which of the following documents you use in your project management work regarding planning.

- [ ] Contract planning (1)
- [ ] Detailed planning (2)
- [ ] General planning checklist (3)
- [ ] Overall planning (4)
- [ ] Procurement planning (5)
- [ ] Work preparation planning (6)

Page Break

Q10 Select which of the following documents you use in your project management work regarding finance.

- [ ] Additional work (1)
- [ ] Budget estimation (2)
- [ ] Financial forecast overview (3)
- [ ] Foundation cost overview (4)
- [ ] Procedure for contingencies (5)
- [ ] Schedule of deadlines (6)
- [ ] Status overview (7)
- [ ] Table of contingencies (8)

Page Break

Q11 Select which of the following documents you use in your project management work regarding monitoring/supervision.

- [ ] Monthly management report (1)
- [ ] Snag list (2)
- [ ] Verification form (3)
- [ ] Verification overview - requirement check (4)
- [ ] VKV report (5)

Page Break

Q12 Select which of the following documents you use in your project management work regarding the delivery of a project.

- [ ] Delivery form (1)
- [ ] Delivery index (2)
- [ ] Delivery record (3)
- [ ] Handover list (4)
- [ ] Statement of observations (5)

End of Block: Current tools in use

Start of Block: Standardised documents

T1 In the following questions you are asked to indicate for your selected documents whether a standardised document is available. If you did not select a document for one of the previous questions, no documents will be displayed. You do not have to make a selection here.

Page Break

Carry Forward Selected Choices from "Select which of the following documents you use in your project management work during the start/initiation of a project."

Q13.1 For which of the selected documents of the start/initiation of a project are standardised templates available?

- [ ] Action plan (execution and project) (1)
- [ ] Construction process diagram (2)
- [ ] External project start-up (3)
- [ ] Feasibility investigation (4)
- [ ] Internal project start-up (5)
- [ ] Interview document (6)
- [ ] Organisation charts (7)

Carry Forward Selected Choices from "Select which of the following documents you use in your project management work regarding contracts?"

Q13.2 For which of the selected documents regarding contracts are standardised templates available?

- [ ] AO (Building Contract/Construction Agreement) (1)
- [ ] Demarcation (2)
- [ ] LOI (Letter of Intent) (3)
- [ ] PoR (Programme of Requirements) (4)
- [ ] Scope of work (5)
- [ ] Specifications of project (6)
- [ ] SPA (Sales and Purchase Agreement) (7)
- [ ] TO (Technical Description) (8)
- [ ] UPD checklist (Exit Points Document) (9)

Carry Forward Selected Choices from "Select which of the schemes you use in your project management work."

Q13.3 For which of the selected schemes are standardised templates available?

- [ ] Communication scheme (1)
- [ ] Construction site layout (2)
- [ ] Consultation structures scheme (3)
- [ ] Drawing rotation scheme (4)
- [ ] Procurement scheme (5)

Carry Forward Selected Choices from "Select which of the following documents you use in your project management work regarding project control."

Q13.4 For which of the selected documents regarding project control are standardised templates available?

- [ ] Action decisions list (1)
- [ ] Agenda (construction) meeting (2)
- [ ] Minutes (construction) meeting (3)
- [ ] Status update form (4)
- [ ] To Do list (5)

Carry Forward Selected Choices from "Select which of the following documents you use in your project management work regarding planning."

Q13.5 For which of the selected documents regarding planning are standardised templates available?

- [ ] Contract planning (1)
- [ ] Detailed planning (2)
- [ ] General planning checklist (3)
- [ ] Overall planning (4)
- [ ] Procurement planning (5)
- [ ] Work preparation planning (6)

Page Break

Carry Forward Selected Choices from "Select which of the following documents you use in your project management work regarding finance."

Q13.6 For which of the selected documents regarding finance are standardised templates available?

- [ ] Additional work (1)
- [ ] Budget estimation (2)
- [ ] Financial forecast overview (3)
- [ ] Foundation cost overview (4)
- [ ] Procedure for contingencies (5)
- [ ] Schedule of deadlines (6)
- [ ] Status overview (7)
- [ ] Table of contingencies (8)

Carry Forward Selected Choices from "Select which of the following documents you use in your project management work regarding monitoring/supervision."

Q13.7 For which of the selected documents regarding monitoring/supervision are standardised templates available?

- [ ] Monthly management report (1)
- [ ] Snag list (2)
- [ ] Verification form (3)
- [ ] Verification overview - requirement check (4)
- [ ] VKV report (5)

Carry Forward Selected Choices from "Select which of the following documents you use in your project management work regarding the delivery of a project."

Q13.8 For which of the selected documents regarding delivery of a project are standardised templates available?

- [ ] Delivery form (1)
- [ ] Delivery index (2)
- [ ] Delivery record (3)
- [ ] Handover list (4)
- [ ] Statement of observations (5)

Page Break

Q14 Is it clarified where these standardized documents can be obtained?

- ○ Yes, they can be found at: (1) _____
- ○ No (2)

End of Block: Standardised documents

Start of Block: Document use

Q15 Please indicate below the minimum, maximum and most common number of people you work with on the same project.
This concerns the internal team of Drees & Sommer.

- ○ Minimum (1) _____
- ○ Maximum (2) _____
- ○ Most common (3) _____

Page Break

Q16 Which digital method do you use to share the project documents?
You can select multiple methods.

- ☐ Harmonie (1)
- ☐ Outlook (2)
- ☐ Sharepoint (3)
- ☐ Teams (4)
- ☐ Other, namely: (5) _____
- ☐ I don't use digital methods to share project documents. (6)

End of Block: Document use

Start of Block: Statements

Q17 Please indicate the extent to which you agree with the statements below.

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
I think it is important that the risks mentioned in the meeting minutes are automatically linked and included in the risk analysis. (1)	○	○	○	○	○
I am experiencing problems making such connections as mentioned in the first statement. (2)	○	○	○	○	○
I think all documents for a project are collected and stored efficiently. (3)	○	○	○	○	○
I think all documents for a project are easy to find and obtain. (4)	○	○	○	○	○

End of Block: Statements

Start of Block: Digi-PM

T2 Digi-PM will serve as a platform on which all project information is gathered together. This will create more overview and automatically make connections between the various documents.

Q18 Would you be willing to invest time to learn how to work with this new platform Digi-PM?

- ○ Yes (1)
- ○ No, because (3) _____

End of Block: Digi-PM

Start of Block: Wishes

Q19 What do you hope Digi-PM can add to your project management activities? In terms of documentation.

_____

End of Block: Wishes

Start of Block: CSFs

T3 In my research, on the implementation of various project management software, I also focus on the critical success factors (CSFs) that influence the implementation. While researching the literature on these CSFs, several factors were selected that are also expected to play a major role in the implementation of Digi-PM. In the next question, you will find some of these CSFs.

Page Break

Q20 Listed below are CSFs which can influence the implementation of Digi-PM. You are asked to rank these elements. For this, number 1 is the CSF which you consider most important and number 11 which you consider least important.

_____ Balanced team, to meet technical and business requirements of the project (project team quality) (1)
_____ Basic education/training on system operation (user training) (2)
_____ Clear and effective communication at all levels of an organization (3)
_____ Effectiveness of project leader (4)
_____ Good relations between employees and with management (5)
_____ Human motivation and support (6)
_____ Involvement of the end users during the implementation (7)
_____ Monitoring and evaluation of the implementation (8)
_____ Open and honest communication (9)
_____ Positive commitment and enthusiastic involvement of top management (10)
_____ The system being accepted by project managers (user acceptance) (11)

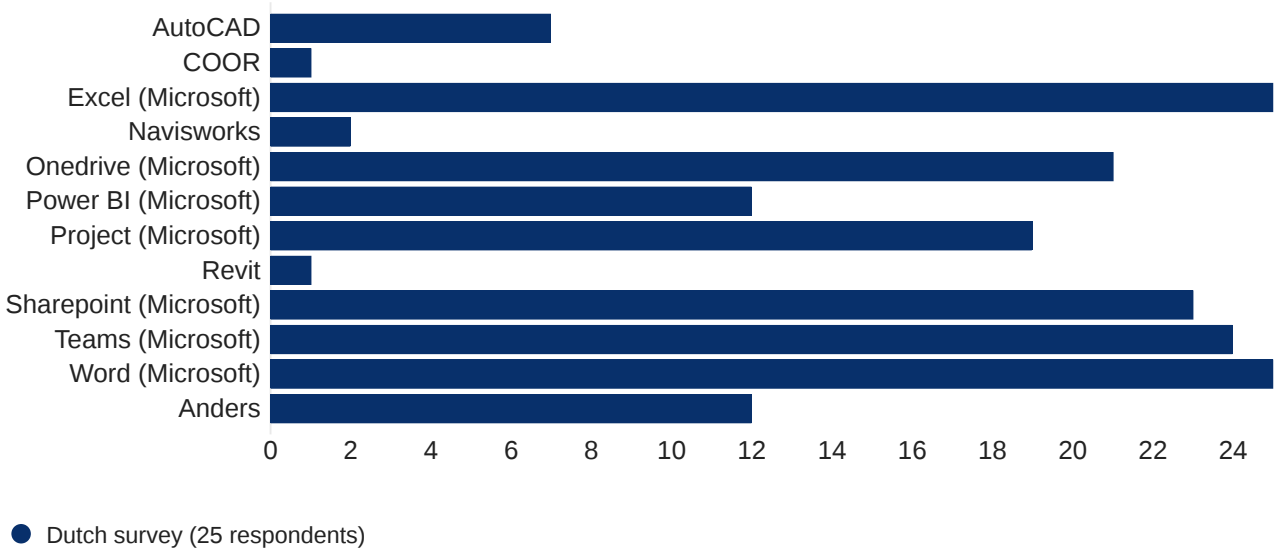
End of Block: CSFs

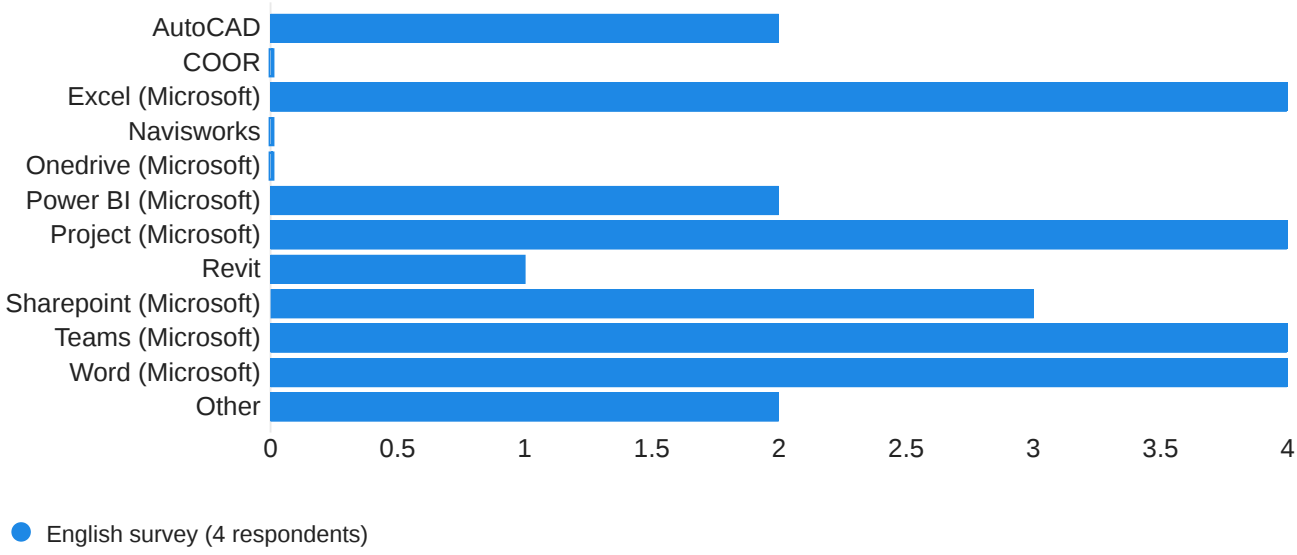
B.4. Survey result report

The document referred to in this section contains the results of the respondents, project managers of the Dutch office of Drees & Sommer. The results of the questions which which add value to the research of the transition from fragmented to integrated digital project manager are included. For document with the survey results you are referred to the next page.

Survey results - Current Digital situation Drees & Sommer Netherlands

Q4 - What software systems/apps do you use when performing project management activities?





Other:
Powerpoint (presenations), PDF editor (edit documents), Solibri (open 3D models), Asana (actionlist internal), OneNote (actions/notes), Siteworks/ACC/Snagstream/EdControls (handover points and recordings on site), SketchUp (modelstudy,feasibility), Adito (crm), Docstream (data management from contractors)

Q5 - Select which of the following documents you use in your project management work during the start/initiation of a project.

Dutch survey (25 respondents)

Field	Choice Count
Plan van Aanpak (uitvoering en project)	19
Haalbaarheidsonderzoek	10
Interview document	1
Bouwproces schema	11
Organogrammen	15
Opstart project extern	12
Opstart project intern	12

English survey (4 respondents)

Field	Choice Count
Action plan (execution and project)	3
Construction process diagram	2
External project start-up	2
Feasibility investigation	2
Internal project start-up	3
Interview document	1
Organisation charts	4

Q13.1 - For which of the selected documents of the start/initiation of a project are standardised templates available?

Dutch survey (25 respondents)

Field	Choice Count
Plan van Aanpak (uitvoering en project)	7
Haalbaarheidsonderzoek	2
Interview document	0
Bouwproces schema	1
Organogrammen	11
Opstart project extern	4
Opstart project intern	6

English survey (4 respondents)

Field	Choice Count
Action plan (execution and project)	1
Construction process diagram	0
External project start-up	1
Feasibility investigation	0
Internal project start-up	1
Interview document	0
Organisation charts	3

Percentage of document users who indicate that standardised documents/templates are also available for the documents they use:

- Action plan (execution and project) : 36%
- Construction process diagram : 8%
- External project start-up : 36%
- Feasibility investigation : 17%
- Internal project start-up : 47%
- Interview document : 0%
- Organization charts : 74%

Q6 - Select which of the following documents you use in your project management work regarding contracts?

Dutch survey (25 respondents)

Field	Choice Count
SPA (Sales and Purchase Agreement)	7
UPD checklist (Uitgangs Punten Document)	15
PoR (Program of Requirements)	15
LOI (Letter of Intent)	13
AO (Aannemingsovereenkomst)	20
TO (Technische Omschrijving)	19
Bestek	19
Scope of work	13
Demarcatie	18

English survey (4 respondents)

Field	Choice Count
Scope of work	4
AO (Building Contract/Construction Agreement)	2
LOI (Letter of Intent)	4
PoR (Programme of Requirements)	3
SPA (Sales and Purchase Agreement)	0
TO (Technical Description)	2
UPD checklist (Exit Points Document)	0
Specifications of project	3
Demarcation	4

Q13.2 - For which of the selected documents regarding contracts are standardised templates available?

Dutch survey (25 respondents)

Field	Choice Count
SPA (Sales and Purchase Agreement)	1
UPD checklist (Uitgangs Punten Document)	3
PoR (Program of Requirements)	5
LOI (Letter of Intent)	5
AO (Aannemingsovereenkomst)	8

TO (Technische Omschrijving)	5
Bestek	1
Scope of work	2
Demarcatie	6

English survey (4 respondents)

Field	Choice Count
Scope of work	2
AO (Building Contract/Construction Agreement)	1
LOI (Letter of Intent)	3
PoR (Programme of Requirements)	2
SPA (Sales and Purchase Agreement)	0
TO (Technical Description)	1
UPD checklist (Exit Points Document)	0
Specifications of project	0
Demarcation	2

Percentage of document users who indicate that standardised documents/templates are also available for the documents they use:

- Scope of work : 24%
- AO (Building Contract/Construction Agreement) : 41%
- LOI (Letter of Intent) : 47%
- PoR (Programme of Requirements) : 39%
- SPA (Sales and Purchase Agreement) : 14%
- TO (Technical Description) : 29%
- UPD checklist (Exit Points Document) : 20%
- Specifications of project : 5%
- Demarcation : 36%

Q7 - Select which of the schemes you use in your project management work.

Dutch survey (25 respondents)

Field	Choice Count
Communicatie schema	17
Bouwplaats inrichting	10
Overlegstructuren schema	20
Tekeningen roulatie schema	13
Inkoop schema	6

English survey (4 respondents)

Field	Choice Count
Communication scheme	3
Construction site layout	2
Consultation structures scheme	1
Drawing rotation scheme	1
Procurement scheme	3

Q13.3 - For which of the selected schemes are standardised templates available?

Dutch survey (25 respondents)

Field	Choice Count
Communicatie schema	8
Bouwplaats inrichting	0
Overlegstructuren schema	8
Tekeningen roulatie schema	5
Inkoop schema	2

English survey (4 respondents)

Field	Choice Count
Communication scheme	1
Construction site layout	0
Consultation structures scheme	1
Drawing rotation scheme	0
Procurement scheme	2

Percentage of document users who indicate that standardised documents/templates are also available for the documents they use:

- Communication scheme : 45%
- Construction site layout : 0%
- Consultation structures scheme : 43%
- Drawing rotation scheme : 36%
- Procurement scheme : 44%

Q8 - Select which of the following documents you use in your project management work regarding project control.

Dutch survey (25 respondents)

Field	Choice Count
Actie besluiten lijst	22
Agenda (bouw) vergadering	24
Verslag (bouw) vergadering	25
Status update formulier	5
To Do list	15

English survey (4 respondents)

Field	Choice Count
Action decisions list	2
Agenda (construction) meeting	4
Minutes (construction) meeting	4
Status update form	1
To Do list	4

Q13.4 - For which of the selected documents regarding project control are standardised templates available?

Dutch survey (25 respondents)

Field	Choice Count
Actie besluiten lijst	15
Agenda (bouw) vergadering	19
Verslag (bouw) vergadering	20
Status update formulier	1
To Do list	5

English survey (4 respondents)

Field	Choice Count
Action decisions list	1
Agenda (construction) meeting	4
Minutes (construction) meeting	4
Status update form	1

Percentage of document users who indicate that standardised documents/templates are also available for the documents they use:

- Action decisions list : 67%
- Agenda (construction meeting) : 82%
- Minutes (construction meeting) : 83%
- Status update form : 33%
- To Do list : 42%

Q9 - Select which of the following documents you use in your project management work regarding planning.

Dutch survey (25 respondents)

Field	Choice Count
Contract planning	17
Detail planning	15
Algemene planning checklist	6
Overall planning	23
Inkoop planning	6
Werkvoorbereidingsplanning	8

English survey (4 respondents)

Field	Choice Count
Contract planning	1
Detailed planning	4
General planning checklist	0
Overall planning	3
Procurement planning	3
Work preparation planning	1

Q13.5 - For which of the selected documents regarding planning are standardised templates available?

Dutch survey (25 respondents)

Field	Choice Count
Contract planning	2
Detail planning	2
Algemene planning checklist	3
Overall planning	8
Inkoop planning	1
Werkvoorbereidingsplanning	0

English survey (4 respondents)

Field	Choice Count
Contract planning	1
Detailed planning	1

General planning checklist	0
Overall planning	2
Procurement planning	0
Work preparation planning	0

Percentage of document users who indicate that standardised documents/templates are also available for the documents they use:

- Contract planning: 17%
- Detailed planning: 16%
- General planning checklist : 50%
- Overall planning : 38%
- Procurement planning : 11%
- Work preparation planning : 0%

Q10 - Select which of the following documents you use in your project management work regarding finance.

Dutch survey (25 respondents)

Field	Choice Count
Meerwerk	20
Begroting	24
Financieel prognose overzicht	13
Stichtingskosten overzicht	11
Procedure stelposten	12
Termijn schema	21
Status overzicht	9
Stelposten overzicht	15

English survey (4 respondents)

Field	Choice Count
Additional work	3
Budget estimation	4
Financial forecast overview	2
Foundation cost overview	0
Procedure for contingencies	0
Schedule of deadlines	2
Status overview	0
Table of contingencies	0

Q13.6 - For which of the selected documents regarding finance are standardised templates available?

Dutch survey (25 respondents)

Field	Choice Count
Meerwerk	9
Begroting	10
Financieel prognose overzicht	5
Stichtingskosten overzicht	3
Procedure stelposten	2
Termijn schema	7
Status overzicht	3
Stelposten overzicht	3

English survey (4 respondents)

Field	Choice Count
Additional work	1
Budget estimation	3
Financial forecast overview	1
Foundation cost overview	0
Procedure for contingencies	0
Schedule of deadlines	0
Status overview	0
Table of contingencies	0

Percentage of document users who indicate that standardised documents/templates are also available for the documents they use:

- Additional work : 43%
- Budget estimation : 46%
- Financial forecast overview : 40%
- Foundation cost overview : 27%
- Procedure for contingencies : 17%
- Schedule of deadlines : 30%
- Status overview : 33%
- Table of contingencies : 20%

Q11 - Select which of the following documents you use in your project management work regarding monitoring/supervision.

Dutch survey (25 respondents)

Field	Choice Count
Maandelijks managementrapport	20
Snag lijst en protocol	18
Verificatie formulier	5
Verificatie overzicht - requirement check	5
VKV-rapport	11

English survey (4 respondents)

Field	Choice Count
Monthly management report	4
Snag list	4
Verification form	0
Verification overview - requirement check	0
VKV report	0

Q13.7 - For which of the selected documents regarding monitoring/supervision are standardised templates available?

Dutch survey (25 respondents)

Field	Choice Count
Maandelijks managementrapport	12
Snag lijst en protocol	10
Verificatie formulier	0
Verificatie overzicht - requirement check	1
VKV-rapport	9

English survey (4 respondents)

Field	Choice Count
Monthly management report	4
Snag list	2
Verification form	0
Verification overview - requirement check	0

VKV report 0

Percentage of document users who indicate that standardised documents/templates are also available for the documents they use:

- Monthly management report : 67%
- Snag list : 55%
- Verification form : 0%
- Verification overview - requirement check : 20%
- VKV report : 82%

Q12 - Select which of the following documents you use in your project management work regarding the delivery of a project.

Dutch survey (25 respondents)

Field	Choice Count
Oplever formulier	21
Oplever index	5
Proces verbaal van oplevering	24
Overdracht lijst	15
Staat van bemerkingen	16

English survey (4 respondents)

Field	Choice Count
Delivery form	2
Delivery index	0
Delivery record	0
Handover list	4
Statement of observations	0

Q13.8 - For which of the selected documents regarding delivery of a project are standardised templates available?

Dutch survey (25 respondents)

Field	Choice Count
Oplever formulier	8
Oplever index	1
Proces verbaal van oplevering	16
Overdracht lijst	1
Staat van bemerkingen	3

English survey (4 respondents)

Field	Choice Count
Delivery form	1
Delivery index	0
Delivery record	0
Handover list	2

Statement of observations	0

Percentage of document users who indicate that standardised documents/templates are also available for the documents they use:

- Delivery form : 39%
- Delivery index : 20%
- Delivery record : 67%
- Handover list : 16%
- Statement of observations : 19%

Q14 - Is it clarified where these standardized documents can be obtained?

Dutch survey (25 respondents)

English survey (4 respondents)

Yes, they can be found at: Teams/Sharpoint (12), Saved them somewhere myself (1).

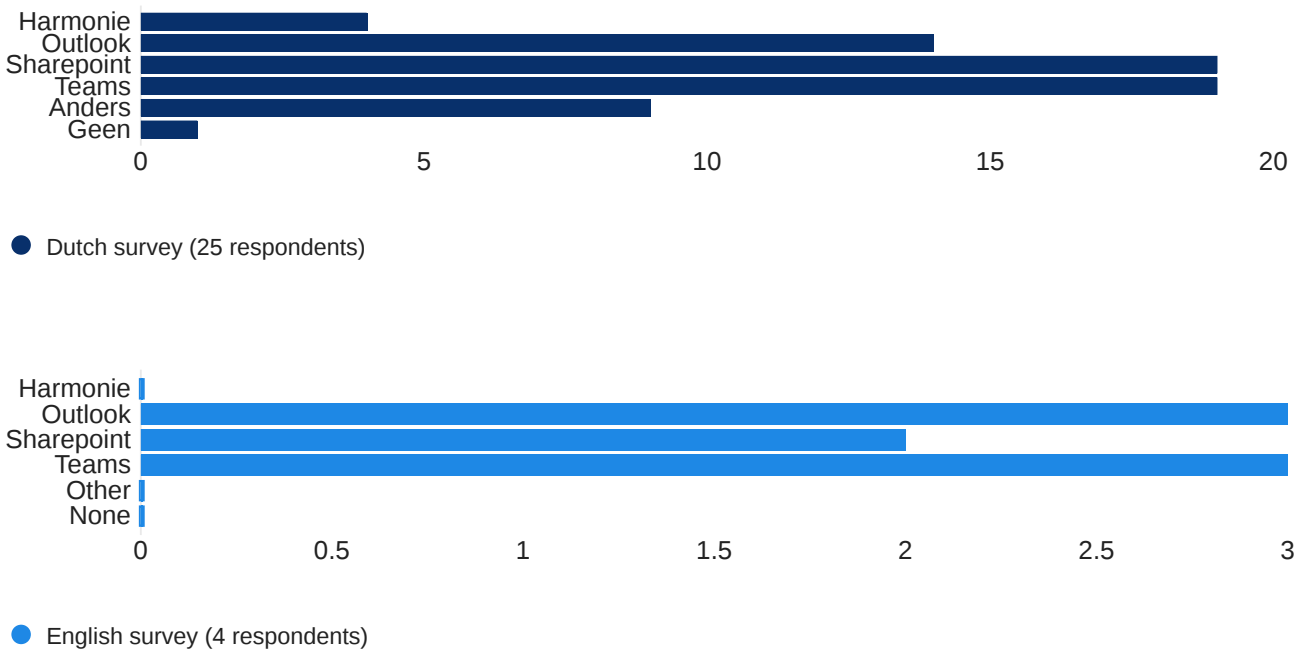
Dutch and English survey combined makes: YES [45%] and NO [55%].

Q15 - Project team size

Percentages of amount of members per project team there are given as answers:

Minimum:	**83%**	**(1 team member)**
	14%	(2 team members)
	3%	(4 team members)
Maximum:	**38%**	**(3 team member)**
	21%	(4 team members)
	14%	(6 team members)
	7%	(5 team members)
	7%	(1 team member)
	3,25%	(2 team members)
	3,25%	(8 team members)
	3,25%	(10 team members)
	3,25%	(15 team members)
Most common:	**62%**	**(2 team members)**
	17%	(1 team members)
	10%	(3 team members)
	7%	(4 team members)
	4%	(8 team members)

Q16 - Which digital method do you use to share the project documents?



Other:
Docstream, WeTransfer, Dropbox, Asana, Trimble

Q17 - Statements to estimate current situation regarding connection between documents and storage.

Dutch survey (25 respondents)

Field	Helemaal niet mee eens	Niet mee eens	Niet mee eens en niet mee oneens	Mee eens	Helemaal mee eens
Ik denk dat het van belang is dat de risico's die worden genoemd in de notulen van de vergadering automatisch worden gekoppeld aan en opgenomen in de risicoanalyse.	0	2	4	14	5
Ik heb problemen met het maken van dergelijke verbindingen zoals vermeld in de eerste stelling.	1	6	3	10	5
Ik vind dat alle documenten voor een project efficiënt worden verzameld en opgeslagen.	4	5	3	9	4
Ik vind dat alle documenten voor een project gemakkelijk te vinden en te verkrijgen zijn.	5	4	3	9	4

English survey (4 respondents)

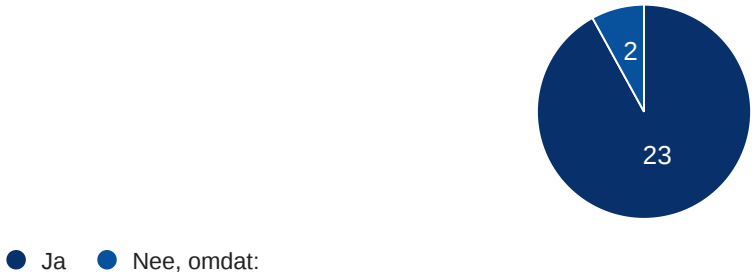
Field	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I think it is important that the risks mentioned in the meeting minutes are automatically linked and included in the risk analysis.	0	0	1	3	0
I am experiencing problems making such connections as mentioned in the first statement.	0	1	1	1	1
I think all documents for a project are collected and stored efficiently.	0	2	1	0	1
I think all documents for a project are easy to find and obtain.	0	2	1	0	1

Distribution of the opinions:

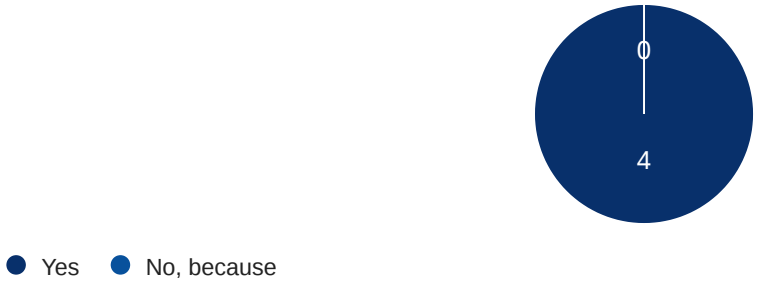
	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Statement 1	0%	7%	17%	**59%**	17%
Statement 2	3%	24%	14%	**38%**	21%
Statement 3	14%	24%	14%	**31%**	17%
Statement 4	17%	21%	14%	**31%**	17%

Q18 - Would you be willing to invest time to learn how to work with this new platform Digi-PM?

Dutch survey (25 respondents)



English survey (4 respondents)



No, because:
Lack of time, going to leave Dreso

Q19 - What do you hope Digi-PM can add to your project management activities?

Dutch survey (25 respondents)

Wat hoopt u dat Digi-PM kan toevoegen aan uw project management activiteiten? Op het gebied van documentatie.
Vergemakkelijking van mijn werkzaamheden
overall project status en resultaat en snelle opvolging open acties
efficientie
Minder zoekwerk, makkelijker werken en te optimaliseren.
beheersbaarheid, uniformiteit, structuur
Overzicht in de documenten
360graden vastleggen bouwsite om op afstand mensen te kunnen laten meekijken met de uitvoering.
Standaardisatie en automatisering in de processen.
kan ik nog niet overzien

eenvoudiger en overzichtelijker maken
Meer standaard documentatie aanwezig. Dus niet enkel lege templates, maar ook ingevulde voorbeelden van andere typen projecten zodat je ook op inhoud van elkaar kunt leren.
Structuur, sturing en deadline management
Documenten kan koppelen en dubbelingen(voor zover mogelijk) kan vermijden. Daarnaast overzichtelijkheid creëren en een standaard algemeen mappenbestand kan voortbrengen welke voor ieder project gelijk wordt ingevuld.
Standaard formulieren
Algemeen antwoord 'efficientie slag'. Daarbij van belang dat er een snelle interne koppeling is tussen verschillende documenten en dat ook de interne documenten die nodig zijn voor een project beter binnen handbereik liggen.
Standaardisatie
Efficientie en verhogen van de kwaliteit van D&S
Het wegnemen van standaardtaken, zodat je kan focussen op de toegevoegde waarde als projectmanager.
efficienter digitaal werken
duidelijkheid

English survey (4 respondents)

What do you hope Digi-PM can add to your project management activities? In terms of documentation.
automatic links between documents/lists, such as MOMs - change/decision management - action list - etc.
Ability to quickly find the form you need
Easiness of storage and communication

Q20 - Assessment of importance level of different CSFs affecting Digi PM implementation by project managers

Field	1	2	3	4	5	6	7	8	9	10	11
Basiscursus/training over de werking van het systeem (gebruikerstraining)	8	4	2	3	3	0	0	1	0	1	2
Betrokkenheid van de eindgebruikers tijdens de implementatie	2	4	1	1	2	5	1	0	1	2	5
Duidelijke en effectieve communicatie op alle niveaus van een organisatie	4	2	5	1	0	5	4	1	2	0	0
Effectiviteit van de projectleider	3	3	1	3	2	3	5	1	3	0	0
Evenwichtig team, om te voldoen aan de technische en zakelijke eisen van het project (kwaliteit projectteam)	0	3	1	1	4	4	3	5	1	2	0
Goede relaties tussen werknemers onderling en met het management	2	0	1	2	2	2	0	5	4	4	2
Het systeem wordt geaccepteerd door projectmanagers (gebruikersacceptatie)	3	3	7	2	2	1	2	1	2	1	0
Menselijke motivatie en ondersteuning	0	1	2	3	3	1	4	1	4	3	2
Monitoring en evaluatie van de implementatie	0	0	1	3	3	0	2	2	5	5	3
Open en eerlijke communicatie	0	3	3	1	2	2	2	3	1	2	5
Positieve inzet en enthousiaste betrokkenheid van het topmanagement	2	1	0	4	1	1	1	4	1	4	5

English survey (4 respondents)

Field	1	2	3	4	5	6	7	8	9	10	11
Balanced team, to meet technical and business requirements of the project (project team quality)	1	1	1	0	0	0	0	0	0	1	0
Basic education/training on system operation (user training)	2	0	1	0	0	0	0	0	0	0	1
Clear and effective communication at all levels of an organization	0	2	1	0	0	0	0	1	0	0	0
Effectiveness of project leader	0	0	1	1	0	0	0	0	0	0	2
Good relations between employees and with management	0	0	0	1	2	1	0	0	0	0	0
Human motivation and support	1	0	0	0	1	2	0	0	0	0	0
Involvement of the end users during the implementation	0	0	0	2	0	1	1	0	0	0	0
Monitoring and evaluation of the implementation	0	0	0	0	0	0	2	1	1	0	0
Open and honest communication	0	0	0	0	0	0	1	2	1	0	0

Positive commitment and enthusiastic involvement of top management	0	0	0	0	1	0	0	0	2	1	0
The system being accepted by project managers (user acceptance)	0	1	0	0	0	0	0	0	0	2	1

Summary assessment importance level CSFs according to respondents:

Ranked from most important to less important

1. User training

2. Communication (clear + effective)
User acceptance
User training
Project team quality
End-user involvement

3. User acceptance

4. Top management involvement

5. Project team quality
Good relation with top management
Human motivation and support

6. End-user involvement

7. Effectiveness project leader

8. Top management involvement

9. Monitoring and evaluation
10. "

11.Communication (open + honest)
End-user involvement
Top management involvement

The places where there are multiple CSFs, the same number of respondents selected that place in the ranking for the respective CSF.

C

Semi-structured interviews

This appendix contains the interview protocol (figure C.1) which functioned as a guide during the interviews. This interview protocol, together with the informed consent (C), was shared with the interviewee prior to the interview. The informed consent document starts after the interview protocol.

Details of interviewee

Name: _____
Age: _____
Employment title: _____
Main work activities: _____
Period employed with Drees & Sommer: _____
Period of work with Digi PM: _____
Role division: _____

Phase / Topic	Before using Digi PM	Transition to Digi PM	While using Digi PM	Helps answering
General	• How did you work before Digi PM? - What was your experience? (Pain points and advantages?) • What was your expectation of using Digi PM before the transition?	• What was the process of the implementation of Digi PM? (What phases and actions?) - How long did the transition process take? • How did you learn to work with Digi PM/the new software? (Training sessions available?) • What challenges have you faced? • What do you think was of real importance for the transition to be successful? (CSF?)	• Have your working activities remained the same since using Digi PM? (New activities or less?) • What is your experience of working with Digi PM? (Pain points and advantages?)	SQ1 SQ2 SQ3
Data input	• What was the process of entering all project information in the different software programmes? (Standard documents?) - Who was responsible?	• Do you have to use other software for your data input because of the transition to Digi PM? (Training?)	• What is the new process of entering all project information in the different software programmes? (Standard documents?) - Who is responsible?	SQ1 SQ3
Data integration	• How did the project data give you a complete overview? (What actions?)		• How does the project data gives a complete overview with Digi PM? (What actions?)	SQ1 SQ3
Data processing	• How did you gather all the information from a project? - Who was responsible? - What insights did this data give you?		• How do you gather all the information from a project now? - Who is responsible? - Gives it other insights?	SQ1 SQ3
Data reporting	• How did you report the data before? (What data and what actions?) - Who was responsible?		• How do you report the data now? (Same data and actions as before?) - Who is responsible?	SQ1 SQ3

Figure C.1: Interview protocol

Dear Mrs. Mr. [*Achternaam*],

You are being invited to participate in a research study titled *"Moving towards digital project management - Implementation of a new digital project management tool in a Dutch consultancy company".* This graduation research is conducted by Kim Baars for the completion of her master's degree in Construction Management and Engineering at Delft University of Technology in collaboration with Drees & Sommer.

The purpose of this research study is to fill gaps in literature studying the digital project management tool implementation in a consultancy and project management company in the Netherlands. Focussing on the transition from a fragmented to an integrated project management system.

Research shows that there is a growing interest in implementing integrated software systems that contribute to project management. Studies on the implementation of these integrated software systems have so far tended to emphasise the benefit of such software. However, there is relatively little analytical evidence to support such assumptions. Therefore, this research aims to investigate and analyse the impact of the implementation of integrated software systems to support project management in a construction consultancy company. The goal is to uncover more about this element in order to better understand the advantages and difficulties of adopting an integrated software ecosystem and how it affects interoperability. Besides that, it focuses on the aspects that are important to take to account when implementing such systems.

During the research interviews will be conducted among project managers within Drees & Sommer. The interview will take approximately 1 hour to complete. The data will be used for identifying the use of current software systems and the cooperation between them. Based on this, the final advice will be created. This will be used in the final thesis document. During the interview, I will be asking you to answer several open-ended questions and I will encourage you to tell as much as possible.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. During the interview, depending on the circumstances, video and/or audio recordings will be made. An automatic transcriber will also be running along. The recordings will be used for the correction of the automated transcription. This corrected version will be shared with you to review. If the transcription receives no comments, the recording will be deleted and the transcript anonymised. The non-anonymised data will be stored in separate folders on my personal TU Delft OneDrive and will be deleted as soon as possible. From the anonymised transcripts, quotes will be included in the thesis report. The anonymised transcripts will be stored as an appendix to my thesis at TU Delft for visitation purposes. They will not be made publicly available as they are not part of my publicly available thesis.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any questions. The data can be deleted up to the point that the transcripts have been agreed upon. Once these have been made anonymous, this is no longer an option. However, after this point all recordings will be deleted.

I would like to thank you for your cooperation and time.

Contact details of the executive and responsible researcher:

Kim Baars
+31 6 54983119
kim.baars@dreso.com or k.baars-1@student.tudelft.nl

Explicit Consent points

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated [17/07/2023], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: • This interview will be recorded (video and/or audio) and an automatic transcription will be running at the same time. • The transcription will be corrected manually and sent to me for review • The recordings of the interview will be deleted 10 days after sending the transcription, unless there are any comments on them • The transcription will be anonymised and quotes from it can be used in the report • The originally non-anonymised transcription will be deleted immediately after anonymisation.	☐	☐
4. I understand that I will not be compensated for my participation.	☐	☐
5. I understand that the study will end around June 2024	☐	☐
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that my participation means that personally identifiable information and research data will be collected, with the risk that I may be identified from this. But that it is possible to ask to stop the experiment at any time.	☐	☐
7. I understand that the following personally identifiable research data is considered sensitive, with the potential risk of my identity becoming known: • Name • E-mail address • Other contact details for digital communication • Video and/or audio recording of this interview	☐	☐
8. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach: • Data will be anonymised as soon as possible • The non-anonymised data will be stored in a separate folder before being deleted.	☐	☐

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
9. I understand that personal information collected about me that can identify me, such as e.g. my name, contact details, and video and/or audio recordings, will not be shared beyond the study team.	☐	☐
10. I understand that the personal data collected about me will be deleted at the latest when the report is published.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
11. I understand that after the research study the de-identified information I provide will be used for developing the advice for implementing digital project management tools and for determining factors of suitable (pilot) projects. In addition, the data will also be used for the thesis report.	☐	☐
12. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
16. I give permission for the de-identified information that I provide on [….-….-……..] to be archived in the TU Delft repository so it can be used for future research and learning. I am aware that only the anonymized data presented in the thesis will be shared.	☐	☐
17. I understand that access to this repository is open.	☐	☐

Signatures

_____ _____ _____

Name of participant [printed] Signature Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____ _____ _____

Researcher name [printed] Signature Date

Study contact details for further information:

Kim Baars
+31 6 54983119
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All interviews conducted were transcribed. One of these transcripts is reproduced in the document as an example representation. This transcript starts on the next page. The quotes from the transcripts were used in the research report and for determining initial codes.

For the thematic analysis of the interview data, the process started with coding the transcripts of the interviews. These initial codes are presented in table C.1. This table shows the initial codes, sorted by code category. In addition, the groundedness of the code is displayed. It indicates how often each code was used and therefore how often the particular topic was raised by the interviewees. The colors indicated a connection between the codes in each code category.

Once all the codes had been reviewed, the codes were sorted and grouped into 'code categories', based on similarity. To obtain the results, data from different code categories were considered for each sub-question. Table C.2 shows which code categories provided input for the results for each sub-question.

While analysing all the different code categories contributing to the results for the sub-question on employee experience, a table was generated. This table (table C.3 contains quotes for the relevant topic with an explanation of the result.

Interviewee:	Interviewee 1 (R)
Age:	35
Function:	Senior project manager
Period employed at Drees & Sommer:	3 years
Drees & Sommer location:	Frankfurt
Period working with Digi PM:	1.5 years
Interviewer:	Kim Baars (I)
Date:	March 27, 2024 at 09:00
Location interview:	Online (MS Teams)

Start interview

I: All right, great. So first is just about the way of working before the transition to Digi PM like. How did you work like real compact, like what kind of software did you use? What was the process of that?

R: Oke, so, we were kind of primarily focused on the different apps of Office 360. So like Microsoft Word, Excel, Microsoft project. Which are kind of the key apps that I'm using for or that I used for my work, so office or Word for the meeting minutes, Excel for the for any kind of calculation and Microsoft project for the scheduling. And, well that's actually it. So all kind of data mining was done by hand. And to create reports. Also, the risk management we were doing with an Excel spreadsheet. That was kind of the way it used to be.

I: And like, you said, it was all like done by hand, all the input of the data. So, who was responsible for that? Was that for, like in your case, you or?

R: Exactly, yes.

I: Or did you have other?

R: No, I didn't have any kind of support. So I was doing everything. We kind of did have some support, for example, for the schedule that the initial one was set up by a colleague, but then kind of maintaining it and working with it was or is my, yeah my task.

I: All right, and for the like the getting a complete overview of the project. For now it's integrated. But how did you create that overview of all the information of a project?

R: Yes, so we are creating or we were creating quarterly based reports. For which we kind of mined the data for the current status of the project. So like time wise, cost wise and if there are any major decisions, have to be taken care of by the client and in general kind of a short project overview of the current status. In a in text form.

I: All right, and how did you reported the data? Like you put it all in Word or did you?

R: Exactly., we kind of were writing the report in Word and then as a PDF file, we were submitting it to the client.

I: All right, so, that was all the responsibility for the project manager. Is it like what kind of insights did it give you when you got all the data together?

R: Well, of course, how the costs are developing. So, if we are still kind of within the budget or how the budget changed. What were the reasons for the change? Have there been some major decisions by the client, or was it just like the general cost of development? Then time wise, of course. Where we are and where we should be. So how the project was ongoing. And also for the risk management we kind of collected the data. How the risks developed, throughout the project. And if we kind of identified new risks because of certain decisions by the client or by the project team. Yeah, that that's actually the majority, yes.

I: Let's see. And how did you experience that way of working?

R: Well, I mean, it was kind of the way we used to do it, so. Of course, you always had kind of the idea or the thought: This could be easier or why do I need to do this all kind of like manually? Why don't I, yeah. Especially kind of collecting the data. I mean interpreting the data is always kind of like a manual work, but the gathering the data from the different applications. Yeah, could have been more user friendly.

I: Yeah, can imagine. So, when are you heard about the transition to Digi PM or to the new way of working, what was your expectations on beforehand?

R: Well, I was, first I was really kind of anticipating this move because I really expected it to be helpful and making my work easier, especially for the data mining that in a kind of in the ideal case I would only have to click one button and then the report would kind of mine the data from the different applications. That was at least some kind of expectation by me. Of course I was also aware that this perfect idea wouldn't work, but something similar to this that was kind of my expectation. My expectation yeah, and also getting some dashboard that update themselves that I can also give, in between our regular reporting process, kind of proper feedback to the client if he needs some information or also for me to monitor the project. When I kind of, when we update the information in the project that I always get kind of a quick feedback for an overview to see where actually are potential problems in the project. Kind of like are we out of time or are we running out of budget?

I: Yeah.

R: That way I kind of do my expectations, yes.

I: All right, great. So, at that moment, you had your expectations and they said, well, OK, we're gonna implement this new tool. What was the process of that implementation for you?

R: So, the responsible colleague here in Frankfurt, he approached me or the team and suggested some solutions and we kind of did a step by step implementation. So, we started with implementing the time schedule in the Digi PM, as well as writing our meeting minutes and with Proman. For this we also did get the support by an intern who was kind of then mitigating the last, I think, 25 meeting minutes. So that we had kind of like a proper status quo in Proman to rely on and then also kind of the report with the information mining was set up by the, this colleague.

I: And with this colleague you mean the responsible colleague for the implementation?

R: Exactly, yes, yeah. So, he, we gave him one of our reports and then he kind of checked which kind of parts he can now change to kind of implement the data mining from the Digi PM. And then, he now and then, he kind of gave us, yeah, like a blueprint for the new report. Which, is now the report we are working with. Unfortunately, we always need to send him then the new report that he updates the data. So, it's not as intuitive as we were hoping. But that's also kind of a licence problem. So yeah.

I: All right, yeah. So that's still an ongoing process then, that they, that you will get the licence to.

R: Well, I was hoping to get a licence, but I fear now after 1.5 years I won't get a licence. But I mean luckily we only submit a report on a quarterly basis. So it's not that much a pain in the ass to ask once per three months for this support. Currently we are kind of setting up our, the cost control tool to also implement in the Digi PM we were kind of waiting for this until we have kind of a fixed budget to then really have like a back baseline and not regularly need to adjust the the budget depending on the decisions of the client and the planning team.

I: All right, so for me, for the reporting then, when you do it right now, you will have to ask if he can refresh the report and then send it to you, All right.

R: Exactly, yeah.

I: So, do you know if that's a common? So that's how it just how the process is or are there also projects for which it's different?

R: There are projects, well as I understood, there are projects where it is different. Where really the project managers have kind of access to the to the Power BI to update their reports without kind of a third party support. But yeah, for us it's kind of this work around now.

I: Yeah, all right. So, and how long did the transition take, approximately?

R: So, kind of the main transition process was really kind of setting up the meeting minutes in Proman. This did take about two-month. And then we kind of really started step by step. Using the different applications and then I think the first report created with the support of the Digi PM was submitted half year later. So, kind of from beginning to the first report it were about six months.

I: So, you worked, if I understand it right, a little bit in parallel with the old and new way.

R: Exactly, yes, it was just like, I mean, it was also kind of a time manner that we were needed to kind of align on how the report should look like. Which information from the Power BI we really want to show in the report, and which are kind of more like attachments to the report, yeah. And this was kind of like an iterative process that took a few weeks. Then also the Christmas break happened in between, so yeah.

I: All right. So, I heard you're talking a little bit about Proman, so that's a new software that you use, but are there others that you had to start using in case for did you PM to work?

R: Luckily not. For example, for the costs we were already using COOR as main cost tool. As I said there, we now only needed, or we are now kind of implementing the fixed budget and kind of setting up everything to then also report to Power BI. And for the time scheduling we used Microsoft Project which is still kind of the main application for the time control. So, the only new application was really Proman. Well, to be fair, I also started to work more diligent with Metis, for the risk management. But that's also, yeah, kind of a downside, because it's also not as intuitive to use as I was hoping for, especially because you can in the report, we are now only kind of showing the five or ten major risks. And then the other risks are an export from Metis in an excel spreadsheet as an attachment, then to the report. And this actual spread sheet, we also need it to rework it after the first export, that the design kind of fits our demands you know.

I: So, how did you learn to work with the new softwares or with the Digi PM? Is that trial and error to say or were there trainings or?

R: So, for Proman, we had a training, but it was also a lot of trial and error. And for Metis it was similar. We also did get a brief training on how to set up different risks and how to kind of maintain them. But again, it was when also more like trial and error, whenever you create a new risk and then you were just like wondering how to do it and also how to create the report.

I: Yeah, can imagine. So, were there like, challenges that you faced during that transition?

R: During the transition itself not but kind of in use,now during the using Proman and I've faced a lot of challenges because how this application works, or the idea behind this

application, is that it's all server based so you do not have a kind of a physical application on your desktop and it's, it's VERY slow. So, it takes me currently way too long to write meeting minutes. I just by out of curiosity I timed for one of my last meeting minutes, how long it takes me to set them up or create them in Proman compared to the actual meeting. So, the meeting was something like 60 to 75 minutes and writing those meeting minutes took me about 90 minutes. So, kind of in general, I like the design of Proman and also the idea of having one solution in which, in an ideal, in a perfect world, every participant of the project would write their meeting minutes. But for us it's only, on my project. It's only us we're using it for meeting minutes. So, also kind of the data that I can mine from Proman is not really useful. I mean the open task that I see, only I see them and it's not like that I can then share a kind of an overview. Where I can tell, OK, we we now have those open tasks and I would wish that this is more intuitive. So, I also learned now that some in some projects for the reporting the project team actually uses a project management software only like Asana, for example, or different ones where you kind of create the issues. And then you have immediately, like a workflow behind that and I think that's a way more intuitive way to work with a meeting minutes. Because, to be honest, when you write meeting minutes, most of them are not read by the people who you address, so you always need to kind of create kind of like a task and then for someone a checkbox and then it kind of works. But like this it's, it's a nice design. But if I could, I would go back to Microsoft Office, to Word.

I: All right, but you cannot?!

R: Yeah, because now there are so many meeting minutes already in Proman and I mean when you have the kind of organising the meeting minutes and kind of looking up old Points. That's kind of handy in Proman because you don't need to kind of then open different files to finally figure out where you wrote a certain point. But this works in Proman way better. Because you can then really look up the different kind of headlines and then you can go through the different parts of which you wrote and this really works well. So, this I also used quite a few times already, but that's currently for me the only advantage that I really figured out for me in the
project.

I: All right, so to have the last idea about the transition. Where there real important factors that you think that influenced the successful implementation.

R: Well, I think one, one of the most important factors was that I was open and willing to do this process. And that I also receive the support of the responsible team here in Frankfurt, otherwise it would be like, here you have the kind of different software solutions and now just go with it. I don't think that it would have happened.

I: So you mean like then trainings or involvement of those people?

R: Yeah, exactly. So, without the support, the training and explaining everything and also kind of explaining the advantages of the different solutions were crucial for me to kind of accept the process. And also kind of accept this, yeah, those downsides, for

example, that I face with Proman. In the beginning I was really an advocate for Proman then, and I encouraged my colleagues also to use it. Unfortunately, they also faced the same issue as I do, so it takes way too long to write the meeting minutes. Also, we figured out that Proman lacks kind of specific vocabulary, so still needs to learn. And nowadays as soon as kind of a word is underlined in red you immediately expect you made a mistake. And it's not like, oh, no the software doesn't know the word. It's more like, where's the mistake? Where's the typo?

I: All right, yeah. That's quite clear. So, we already talked a little bit about the working activities and and how you experiencing them. But like the activities that you have to do for your project management work, did they remained the same when start using Digi PM? Or were there more activities or less or new activities?

R: In general, they stayed quite the same. I needed to adjust a bit, for example also with our schedule in MS Project because we kind of had an overview in the beginning, which kind of summarises the milestones, which are then in the actual schedule, and to prevent the double upload from the those of those milestones, we always need to delete those summarising milestones in the beginning, then we can push the schedule to Power BI and then we just need to go this deleting step back. To have kind of the overview as the project teams knows. So, actually this created, it's not a big step, but it created another working step we needed to take care and it took us also a while to figure out why we have those double milestones in the reporting. So, that was, it's also a bit unhandy, but in general, the Digi PM doesn't support me as much as I hoped for I'm actually hoping that this whole AI trend now with the Microsoft copilot will support me more. With respect for kind of data mining and also kind of finding information way quicker in the different Microsoft solutions. So, I can see some advantages for the for the Digi PM, but you really need to, so for me we implemented it while the project was already ongoing. I can see a lot of advantages when you really kind of set it up in the beginning, especially when you're already kind of aligned with the client. Which solutions you want to use, and the architect and the engineers are still not part of the project team. So, yo can really kind of force them by the contract to use certain software solutions, and then when everyone is working with the same software. I can imagine that the reporting is way more valuable. For now it's more like a nice toy to have.

I: All right. So, that's actually was more about the experience. So, you that's actually it, I think. You can see some advantages if you would use it at the start, start using it at the beginning of project. But for now it's more getting to know getting to know the software than really getting out of it what you expected to?

R: Exactly yeah, it's exactly this. So, I mean, I also recommended some of my colleagues to really start using, for example, Proman from the very first beginning. Well, they didn't do it from the very first beginning, but after a few meeting minutes. But there's also the problem that they are working with a different project communication system, which doesn't have any connection to to the Power BI. So, again, you can only get a then a certain amount of information, which is also caused by the fact that the project was already running when we got contracted. So, it's always kind of like there

are a lot of great options within the Power BI world to use. But yeah, you really need to start to use them before the project actually really kicks off.

I: All right. So, about that using of the Digi PM, like of entering all the data and projects in the different software systems? What was the new process, was there a new process?

R: Yes, I mean for the reporting, it did get a bit handier because I didn't need to kind of go then back to my schedule to then figure out the the different dates of the milestones. As soon as I update my schedule, I just push it up to Power BI and then after I forwarded the report to my colleagues to update the information I already received the the actual dates. Same for the risk management for the costs, I hope it will be similar soon. Yeah, but as I said, how to use the the information from Proman that I can mine and kind of push to Power BI. I still didn't figured out a useful way.

I: Yeah, so, but since you start working with the Digi PM, are there any standard documents that you use? Or did you already use that before? That's also possible of course.

R: So, the only standard document is really the report. And OK, in a certain sense, although the the schedule, which is all kind of a standard document, which we then continuously update. But, other documents we are not using no.

I: All right, and like for all the project data. How does it give you that overview? Is that a different, is that in a different way now, then that you had before using Digi PM.

R: Well, especially for the schedule I get those milestone analysis's. Which is kind of an interesting way how to see the project development. To be fair, in the project size I'm working in, I'm not updating the milestones as regularly as it happens in projects that are big enough that you have kind of a dedicated project manager for a schedule of tasks. So, for me it looks more like a stair, and it's not like a proper curve that you can then really tell. So, it's, it jumps for me.

I: Because, firstly, you had all those different kinda softwares, you said, like mostly of the Microsoft type of software but for now, of course you have the Digi PM also for giving that overview of all the data of a project together. How does that give you, how do you gather all that data?

R: Well, I mean I have the the project dedicated dashboard in Power BI. But then for the data mining for the report, it's really kind of the prepared links to those, to the Power BI, which are then updated and in combination with the, with my, with the project overview in Power BI, I kind of mine the data for me and for the report. Also for the texts that I'm writing.

I: Yeah.

R: I'm still also in a regular exchange with the support team here in Frankfurt to kind of reduce the amount of text that I need to write or where we can reduce it. I guess the next the biggest help it would be really for the cost control as soon as we then really kick off COOR and push it up to Power BI because that's actually, anything that is number based, you can easily also report in, or kind of collect the data and report and add it to the report in form of a chart or something like this. And there you don't really need any manual work anymore. You just need to kind of make sure that the data is up to date.

I: Yeah, all right. So, for me, like the Power BI desktop version gives that overview of the whole project for you. Like does it give new or other insights of the project before than before using Digi PM?

R: It makes it easier for me to access a certain information, but because we're not using every option that we could use in Power BI or also the software solutions that we could use. It's kind of like quite basic and then I'm so much involved in this project that actually I'm kind of the major data source. And I primarily use Power BI just to kind of ensure that my knowledge is still right or up to date. So, it's kind of like for me, it's primarily a confirmation option.

I: Yeah, all right. That's quite clear. You said you're responsible for all the activities, so I will, well, assume that for the reporting for putting all the data in. The only thing you mentioned is that for like refreshing the report, so when you had put in new data into the data warehouse. It's via your colleague.

R: Exactly, yes.

I: Can you maybe, I don't know, maybe tell who that's colleague is?

R: Yes, his name is Nikolas Greif, and he's kind of the responsible expert here in Frankfurt for the Digi PM.

I: I'll write that down. And do you know if he is doing that for other projects as well?

R: Yes, yes, definitely.

I: He is also working a lot with Digi PM himself?

R: Yes, yes. He's also the one who's kind of pushing Digi PM in the different projects and in certain projects, I think in for the T3 terminal, here at the airport in Frankfurt, he's also actively working or participating in the project.

I: All right, great. Then I will try to contact him as well to see how his perspective is. That's great.

R: I really recommend this.

I: I think that was quite it, but we went through it, yeah, quite quick. But it was all quite clear. You came prepared, I can say. So, yeah, that was it for now. I will go through it a little more. I think we went through everything that we needed to, so I want to thank you very much for your time again and I will stop recording I think.

Table C.1: Initial codes thematic analysis

Code categories	Initial codes	Groundedness
Adaptability to needs	Finding right way to report	1
	Possibility to adjust to needs	9
	Balance between being adjustable and standardisation	1
	Clients needs are different than standard template	1
	Not in line with needs	1
Adaptability to needs Software tools	Variety of things possible with new tool	2
Better way to report	Nicer way to show data	1
	Reporting works better	2
	Share everything by one click	1
Connection between different systems	Changed to make readable for data warehouse	1
	Data matches in different sources	1
	Everything works together	2
	Project data more connected	4
	Right connections to data warehouse	4
	Right data input	6
	Change in templates causes problems	1
	Losing connection to data warehouse	1
	No data loss anymore	1
	Single source of truth	1
	Compatibility issues	1
Convincing people	Used to	2
	Convince client	1
	Convince people involved	1
	Encouraging colleagues	2
	Tough to convince colleagues to use it	1
Correlation age and open for change	Young company fits with nice tools to use	1
	Young, familiar with software	2
	Young, open to new stuff	1
Correlation age and open for change Not open for change	Older colleagues hold on to old processes	2
	Older not open to new stuff	2
	Older people struggle	3
Data must be up-to-date	Data be up-to-date	1
	Data not up-to-date	1
	Making everyone putting data in on time	2
	Not up-to-date overview all times	1
	Not regularly updating	3
Expectations of new system	Expected acceptance for change	2
	Expected connected data	2
	Expected higher quality	2
	Expected it to be helpful	2
	Expected to make work easier	3
	Expected to save time	2

Continued on next page

Table C.1 Continued from previous page

Expectations of new system	• Expected automated overview	1
	• Expected automated report	1
	• Expected more automated work	1
	• Good looking reports	1
	• More things to show than before	1
	• Less tools	1
	• One project environment to work in	1
	• Really optimistic	1
	• Tools and information connected	1
	• Does not support as hoped	1
	• Should be able to do it independently	5
Experienced change in working process	• Can't fake data	1
	• Dive deeper into date	1
	• Different process	1
	• Not easier, but different	1
	• Partly dependent on others	12
	• Be more in front of things	1
	• Checking data earlier	3
	• Putting in data earlier	1
	• Faster later in process	2
	• Helps to not forget things	1
	• Less confusion	1
	• Better communciation	1
	• Less reciprocal communication	1
	• More client involvement	1
	• More involved in project	1
	• People feel more responsible	1
	• Increases efficiency	3
	• Information sharing got faster	1
	• Less manuel work	3
	• Less workload now	17
	• Less workload now	3
	• Saving time	2
	• Quality check	6
	• Less workload later in process	1
	• Possibility to improve bad processes	1
	• Rethinking the old processes	2
Experienced change in working process Expert involvement	• Expert as consultant	1
	• Expert part of team	1
Expert involvement	• Expert knows architecture of the software	1
	• Possibility to ask the expert	5
Expert involvement Factors for success Set up process	• Document set up by expert	3

Continued on next page

Table C.1 Continued from previous page

Expert involvement Factors for success	• Expert support	25
Factors for success	• Client involvement	1
	• Endurance	1
	• Being consistent	1
	• Invest time and money	1
	• Knowlegde centre	3
	• Structure to connect	8
	• Client acceptance	3
	• Clear concept	2
	• Clear on output you want	2
	• Clear understanding of project needs	2
	• Make them familiar with the tool	1
	• Sharing of advantages	3
	• Sharing of disadvantages	1
	• Software selection	1
	• Clear understanding of goals client	3
	• Acceptance of new layouts	1
	• User acceptance	3
	• Align with needs	1
	• Be able to adapt	1
	• Intrinsic will	1
	• Mindset	2
	• Motivation of the team	1
	• Open for new process	3
	• Open to different tools	1
	• Willingness	1
Factors for success Set up process	• Don't rush	1
	• Decision making on use	2
	• Good foundation	2
	• Importance Digi PM kick off	1
	• Invest in foundation	1
	• Set up process	5
	• Setting up good structure	8
Factors for success Learning process	• User training	9
Factors transition time	• Bigger project size	1
	• Implementation process of 1 month	1
	• Implementation process of 2 months	4
	• Implementation process of 3 months	1
	• Transition time	5
	• Iterative process	1
	• Keep developing 1	1
	• Ongoing process	9

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Table C.1 Continued from previous page

Factors transition time Set up process	Step by step implementation	9
Learning process	Not as intuitive as hoped	3
	For some harder than others	2
	Learning by doing	6
	Learning by working along	1
	Learning new software	10
	Trial and error	5
	Explanation on the new tool	7
	Helped by colleague	1
	Not really hard to learn	1
Limited standardisation in old process	No centralised data input	1
	No standard process	2
	Copying old files	4
	Issue with standard templates	2
	Mistakes are included by takeover templates	1
	Standard templates adjusted	2
	No single source of truth	1
	No standard templates	4
	Developing from scratch	1
	Less standardised	1
Limited standardisation in old process Manual work	Higher failure quote	4
Manual work	Not failure proof	1
	No single source of truth	1
	Manual work	19
	Human factors	2
	Not the best quality	1
Manual work Overview before new system	Repatative work	1
No connection between different systems	Creating own database	1
	No database to connect	1
	Separate software tools	4
	Systems that are not connected to data warehouse	4
	Contradictory information from different tools	2
	Losing data	2
	Loss of knowledge	1
	No platform to combine all tools	1
	Not connected to the documents	2
Not open for change	Clients doesn't want digital reports	1
	Clients have own systems	1
	People don't see the advantages	1
	People don't want to use it	1
Not really big changes in work	No change	1
	No different insights	1

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Table C.1 Continued from previous page

Not really big changes in work	Work for clients remained the same	1
	Worked remained the same	2
	Not harder	1
	Not that different from before	1
	Same stuff different tools	1
Overview before new system	Exported graphs form excel	1
	Creating it for clients	4
	Creating own overview	12
	Report as overview	4
	Big ugly excel sheets	1
	Data spread across different files	1
	Lot of work	2
	Difficult to have overview	1
	Go through all different tools	11
	Not one thing to see it all	2
Parts of work automatically done	Automated overview	5
	Automated work	13
	Automatically done with one click	10
	Manual work changed to automated	2
	Semi-automatic	4
	Not totally automated upload	3
Parts of work automatically done System gives good project overview	Dashboard shows all information together	1
Reporting before new system	Combining different reports	2
	Combine data intro reports	5
	Putting data together in presentation	1
	Hard to report	1
	No high engineered reports	1
Set up process	Easier in the future	1
	Strict acces to data set Power BI	1
	Technical issues	1
	Setting up takes time	4
	Software has to work	2
	Input data in all different tools	2
	Lot of work to get tools running	1
	Lot of work at beginning implementation	1
	Takes more time in beginning	3
	Most time taking	1
	Getting better each time	2
	Clarified language at start	1
	Good set up template	1
	Not in parallel with old	1
Set up process	Old and new in parallel	2
Factors transition time Set up process	Step by step implementation	9

Continued on next page

Table C.1 Continued from previous page

Software tools	Takes more time than before	1
	Difficult tools	1
	Not using full potential	1
	Not user friendlt system	1
	Very slow system	1
	Easy to export	1
	Power BI for reports	5
	Easier to upload	1
	Positive features	2
	Same tools	2
	Tools good to use directly	1
	User friendly	1
	Very intuitive	1
	Most MS Office tools	13
	Not all things feasible	2
Standardisation	Pre-designed reports	1
	Standard process	2
	Standard templates	20
	Standardised way of reporting	3
	Forced to work in a way	1
	Less flexible	3
	Easy to work with	1
	Higher quality	1
	Easier at start of project	1
	Good structure	1
	No old data included	1
System gives good project overview	Graphics instead of text	1
	Dashboard as main information source	1
	All data at one point	8
	Challenging to get what you want	1
	Easier for whole project	1
	Faster feeling	3
	Indicated positive feeling	7
	Better overview	5
	Dreamed about	1
	Easier data analysis	1
	Interactive project data overview	4
	Power BI gives complete overview	14
	Select which topic you want to see	2
Usefulness varies per project	Not enough data for it to be useful	1
	Smaller project size	1
	Used as confirmation tool	1
	Doesn't work on all projects	1
	Not the same for each project	1

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Table C.1 Continued from previous page

Usefulness varies per project	• System works for single project	1
	• Adjustments needed for multi projects	1
	• Not very useful yet	2
	• Not to implement in ongoing projects	1
	• Implementation in ongoing project	3
	• Not implemented on all projects yet	1
	• Taking to much time	1
	• Implementation at start of project	5
	• Not all projects need support	1

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Table C.2: Code categories used per sub-question

	Code category
SQ1 Fragmented vs. integrated	Better way to report Connection between different systems Limited standardisation in old process Manual work No connection between different systems Overview before new system Parts of work automatically done Reporting before new system Standardisation System gives a good project overview
SQ2 End-users response	Adjustable to needs Connection between different systems Convincing people Correlation between different systems Data must be up to date Expectations of new system Experienced change in working process Expert involvement Factors transition time Not open for change Not really big changes in work Parts of work automatically done Set up process Software tools Standardisation System gives a good project overview Usefulness varies per project
SQ3 Important success factors	Expert involvement Factors for success Learning process Set up process

Table C.3: Results of the data analysis on the employee experience

Experience transition process

1. Setting up takes time

Statement interview	Explanation of result	Perspective
”And then we started, after the kickoff, where all the decisions were made, we started to put in all the data into the tools of course. One thing that was a little bit, one thing that took time was getting (...) How to get access to all the tools with your ID and stuff. We had to talk with IT and everything to get all the access, IDs and everything.” *Interviewee 4*	At the start of implementation, access must be granted to the various systems. This process takes time because it has to be arranged with different parties. This will especially be the case when using new software tools for a project.	Project manager
”I think, also it was mostly some technical difficulties that the files had the right connection to Power BI, and that it was showing the right way, so that the client could always also see the stuff that we told him he could see. So, that was maybe one thing that took a little longer.” *Interviewee 5*	When setting up a new project, the right connections must be made to the database so that it can be communicated with the visualisation tool (in this case, Power BI). The technical problems that emerge because the connections are not correct take time. Problems that would not easily occur before the transition to the integrated way of working.	Project manager

2. Usefulness varies per project

Statement interview	Explanation of result	Perspective
”It’s kind of like quite basic and then I’m so much involved in this project that actually I’m kind of the major data source. And I primarily use Power BI just to kind of ensure that my knowledge is still right or up to date. So, it’s kind of like for me, it’s primarily a confirmation option.” *Interviewee 1*	For smaller project less convenient because project manager is often alone on a project. As a result, he/she often knows everything about the project, so the system is used more as a confirmation tool and not the full potential.	Project manager
”For one single project, I think, the Power BI tools and the Dress report is quite good. Because this is the most time we use it. And we have some multi projects, and has to change, and adjust the tools for that. And when you change something in the data framework, or adjust something, it’s, yeah, a little work to get there where you want to be.” *Interviewee 3*	The structure of the new system is suitable for single projects, but to make it workable for managing multiple projects in as 1 project, many adjustments need to be made. This customisation is not so easy because of the connections to the database.	Project lead
”And we looked at all the established processes, and all the established reports that we had, and we came to the point that it would have taken such a big effort to recreate all these reports, and all these processes in order to make them Digi PM feasible.” *Interviewee 6* ”so for me we implemented it while the project was already ongoing. I can see a lot of advantages when you really kind of set it up in the beginning, especially when you’re already kind of aligned with the client. (...) then when everyone is working with the same software.” *Interviewee 1*	The implementation of the new integrated project management tool can only be done at the start of a new project. One can then ensure that everyone is working with the same software so that all project data can be collected on the database, making the most of the benefits of the integrated system. Besides that, for an ongoing project, the transition will take too much time, making it unprofitable to undertake this transition.	Project lead Project manager

3. Rethinking old process

Statement interview	Explanation of result	Perspective

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Table C.3 Continued from previous page

”A lot of people were just kind of doing their own thing. And now that we basically force everyone to rethink the way that they work and report their projects. That can change a lot, or first make you discover a lot of bad processes and help you fix them.” *Interviewee 9* ”So, for myself, the transition was then, of course, to rethink myself. Rethink all my internal thoughts about processes from my old world. With the old project to the new project with Digi PM.” *Interviewee 6*	The transition to a new work process gives employees the opportunity to take their current way of working under the microscope and critically look at where there are areas for improvement. Because they are at the beginning of a new process, it is easy to still include and incorporate this in the new process.	Project lead Project manager

4. Convincing people of the new process

Statement interview	Explanation of result	Perspective
”Because some of the companies, you know, they’re a little bit conventional, and they say: “yeah, we don’t want to use all the digital tools, just work how you like it, but send us a PDF in the end. You know, we only want to see like one PDF document. We don’t want to use power BI for reporting. It’s too digital for us.” *Interviewee 4* ”I’m not trying to age shame. But maybe for the older, more experienced colleagues, it’s bit harder to let go of the old ways of working, and accepting the new ways.” *Interviewee 5*	Many employees and customers are used to the ’old’ way of working. This makes it difficult to convince them why a new integrated project management tool should be implemented. It is perceived that the seniors within an organisation often stick to the old process.	Project manager
”I would say the most, or the biggest challenge was, all the people who were involved. So, we had to get ideas from the Digi PM people, we had to convince our client to use it.” *Interviewee 5*	To use the new system to its full potential, it is important that the client also accepts the new way of working. The client will in fact receive more integrated and interactive reports.	Project manager
”But I still think that it’s pretty tough to get the colleagues to the point where they want to use the method. Because there are certain people who just believe in it, and there are others who don’t.” *Interviewee 7* ”Drees & Sommer is not very strict. So, if somebody finds excuses not to use this method because of this, and of that, that’s always possible. Maybe that will be more and more difficult in the next few years, because we’re gonna have this approach, that actually every project should start with a digital solution, digital strategy.” *Interviewee 7*	Employees are not all convinced and it is difficult to get them to use it. This is partly because it is not yet a hard requirement within the organisation.	Expert DigiPM / Project manager

Experience of working with the new system

1. Takes more time

Statement interview	Explanation of result	Perspective
”It is that it’s all server based so you do not have a kind of a physical application on your desktop and it’s, it’s VERY slow. So, it takes me currently way too long to write meeting minutes.” *Interviewee 1*	Working with one of the new tools takes more time because it is very slow. This is because it is a cloud-based system that requires using the internet. As a result, the speed may depend on the strength of the internet connection.	Project manager

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”It takes more time, in one way it takes more time just because we are forced to work how we should work.” *Interviewee 7*	A standard structure is needed for the new system, so that all data is readable by the database. This forces users to work in a certain way, and this makes the work take more time than if someone can work in his/her own (taught) way.	Expert DigiPM / Project manager

2. Less flexible

Statement interview	Explanation of result	Perspective
”I think the, a lot of challenge is because you’re working less with like this general tools like, with office products, you use more specific tools that are specific for the task, for example cost management tool, like COOR. Or with time management, you use MS project, but you’re not that flexible anymore.” *Interviewee 2*	There is only a selected group of software tools that can connect to the database. Therefore, there is less flexibility in choosing and working with different software systems.	Expert DigiPM
”Especially for schedule planning that you have these, we call it the wizard. It’s already implemented, like, in MS Project, but we are not free to divide from that structure. It’s providing us, we have to make sure we are in that structure otherwise we don’t, we are not able to use it.” *Interviewee 6*	Because a certain structure is required in the documents to commingle with the database, it is not possible to modify this structure just like that. This reduces users’ flexibility in organising project documents.	Project lead

3. Losing connection to database

Statement interview	Explanation of result	Perspective
”change the templates or the Digi PM tool templates a little bit, for example in Ms project. (...) some connections change, and all of a sudden the project doesn’t give you the information that you want. (...) That isn’t really that easy to handle, because it makes the work a little bit annoying.” *Interviewee 4* ”It’s via Power BI, and it’s a dashboard that just, I don’t know the actual way it works. I just upload the information via the Word, Excel and whatever file, and it gets translated into a better looking dashboard for us, and the client.” *Interviewee 5*	When a change is made to the standard templates, the connection to the database may no longer be correct. This is difficult to solve by the users directly, as they often have no idea how the system works in the background.	Project manager

4. No big changes

Statement interview	Explanation of result	Perspective
”a lot of the the activities have remained the same.” *Interviewee 4* ”So for example, cost management basically remained the same, because we were using this tool beforehand, and now we are using it as well. But now it’s connected. (...) We can still use the same way of working, and it’s still working.” *Interviewee 6*	All tasks have generally remained the same because the same software tools can be used in some cases. When a connection can be made with the software tools already in use, it will not be a big change for employees.	Project lead

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”I didn’t even notice that it’s something super different to the world before, because you just do the same stuff with other tools.” *Interviewee 6* ”So, everything we do for the clients remains the same. But the back end, like how we work in Drees & Sommer, as a project manager changed a little bit. Because we use all the tools.” *Interviewee 4*	New tools have nevertheless been implemented for some work. The work will not change but its implementation will be done in new tools. This makes it necessary to invest time in the beginning to learn the new software tools.	Project lead Project manager

5. Better project overview

Statement interview	Explanation of result	Perspective
”Well, for the overview we have our Digi PM cockpit, right. So, as soon as we connect the tools, and the data to our database. They have like a, they can access the cockpit in order to look at the standard visuals.” *Interviewee 9* ”And now, the Power BI report can combine all the details, and give you a better overview of, why are things like they are right now. So it’s a better overview, you can combine more information. And the tool can do the work for you. Because before you had to use your brain to combine it, and now Digi PM can help you with that.” *Interviewee 4*	From the moment all software tools are linked to the database and their data can be communicated, all project data can be shared via a dashboard. This combines all project data, making it very easy to obtain an overview of the project.	Expert DigiPM Project manager
”Now there is one, compared to before. We do use a dashboard in a project. It’s just by one click, you can change the topic you want to see. And you have like all the open to do’s, the scheduling, the risks all in one place.” *Interviewee 5* ”Before, it was manually with, for example, the PowerPoint chart or something and now it’s with using power BI for example. So, you have not like this, just a classic report that you print out or you just have it like that. You can interact with the data.” *Interviewee 2*	An automatically generated overview is available in which all project information is visible. The platform on which this overview is displayed is interactive, allowing users to select the data they want to see. This makes it easier and faster to analyse the project information.	Project lead Project manager
”I think now the you get a quicker overview of the project, when the data is filled in the right way.” *Interviewee 3* ”So, we do like a little two step. From our file to the dashboard, and from the dashboard to the report. And that’s just a few easy clicks. No, really, we don’t really have to format anything. It’s just way easier than before.” *Interviewee 5*	Because all project data is collected on the database, which in turn communicates this data to the visualisation tool (in this case Power BI), a lot of time is saved for getting an overview and preparing a report.	Project lead Project manager

6. More project involvement

Statement interview	Explanation of result	Perspective
”I think on at some points you are more in the project, and know more about the things that are going on. Because you have to, and you don’t forget things because of this frameworks, you have for the data to drop in.” *Interviewee 3*	Because the project information needs to be updated regularly to keep a good overview of the project, it is perceived that users are more invested in the project.	Project lead

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”But it changed that all the people also feel responsible. Because now it’s easier for them to fill in the templates. So, I would say, they face it now.” *Interviewee 8*	Because it is easier to enter project data since there are now standard templates and structures, entering project data is done sooner. As the data must be kept up to date, users feel more responsible for entering this project data.	Project lead
”Just the sharing of information is way quicker, on both sides. The only questions that we now get from the client is: “Oh, I’ve seen there’s a change in scheduling. Could we maybe talk about it, or we have to talk about it.” So, the client gets more involved in, in some parts of the project.” *Interviewee 5*	It is perceived that getting a complete overview of all project information is a lot easier than before.	Project manager

7. Easier

Statement interview	Explanation of result	Perspective
”It makes it easier for me to access a certain information,” *Interviewee 1* ”So, you have a way easier. Process to get in touch with your data and to see through your data and to analyse the data, (...) you can open just a dashboard and then you see all yours data. I mean it’s easier.” *Interviewee 2*	It is perceived that getting a complete overview of all project information is a lot easier than before.	Expert DigiPM
”We have more templates, so it’s easier to know in the beginning if I use this or that tool. I have this template that I have to use.” *Interviewee 4*	The introduction of standard templates for communication between systems makes the start of a project easier. This is because it is clear what to work with.	Project manager
”I think the everyday working just got easier. Just by one click you can share everything, that you’ve just been working on.” *Interviewee 5*	All the work can be shared a lot easier. Partly because of this, daily work is perceived as easier since the transition to the integrated system.	Project manager

8. Adaptability to needs

Statement interview	Explanation of result	Perspective
”I think the biggest issue for a success is that the Digi PM is adjustable. (...) it’s difficulty because for data you have to have a framework, but building projects are always single projects, and every building is different. And every client is different, and it has to be adjustable.” *Interviewee 3*	It is experienced that it is difficult to have a balance between standard templates and adaptability to user or customer requirements. Since the connection to the database has to be maintained.	Project lead
”I think it’s about reports from the client.There are some reports set in the Power BI already, and you can say I use the Dreso report, and everything is fine, everything works perfectly. And, our client don’t want this report. They wanted a little other way, and so we had to build our own Power BI.” *Interviewee 3*	The standard templates of the report do not always meet a customer’s needs and requirements. This makes it essential to be able to make adjustments. However, this does take a lot of time because these have to be adapted technically and will therefore involve several parties.	Project lead
”a lot of customers still want like this typical PDF report. (...) So, you have to keep this in mind when you create a actual report. But, I think our Digi PM team is aware of that problem and there are templates and stuff. They are made to work as a interactive dashboard as well as a static PDF report,” *Interviewee 2*	There are customers who do not want to use the new interactive way of reporting. This makes it important to also offer an option where a PDF can be shared. This should be taken into account when setting up the implementation.	Expert DigiPM

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Table C.3 Continued from previous page

9. Dependent on other

Statement interview	Explanation of result	Perspective
”Unfortunately, we always need to send him then the new report that he updates the data. So, it’s not as intuitive as we were hoping.” *Interviewee 1* ”the person who’s responsible for Digi PM for us. (...) we go to him, and say the data is right in the MS Project scheduling, and he does all the upload into the power BI. And the upload of the Risk management excel sheet, he uploads it when we say the data is right.” *Interviewee 3* ”But I’m always in need of supporting people, so that sometimes can a little bit annoying.” *Interviewee 8*	Updating the data in the powerBI is done by the Digi PM responsible/expert of that location. Sometimes it is annoying that this does not allow a user to do all the activities all by him or herself.	Project lead Project manager
”The technical part, the connected PowerPoint and stuff like this is done by the tools guys, that are also technical responsible for the whole Digi PM thing.” *Interviewee 6*	Technical part is done by the Digi PM responsible/-expert, which makes it hard to solve a problem as a user.	Project lead
”the way how it’s supposed to be, is that I can do all of it. Like I put in the data, I make sure everything is up to date, and then I only click to synchronise. and update all the data in Power BI. And then Power BI does all the work, and I don’t really have to talk to the Digi PM responsible. But that is the thing that sometimes doesn’t work that easy.” *Interviewee 4* ”At the beginning, maybe it’s one of the Digi PM guys, but this should not be the solution. Like as I said before, we should always be able to leave the project, and to go to another project.” *Interviewee 7* ”So, we try always to make the first two reports with the team, and then see if they can run on their own. Usually it’s not the case, but still we try to push them in a direction” *Interviewee 9*	It should be possible for users to go through all the steps of the process independently, without needing help from the expert. However, practice shows that this is not that easy. This is an ongoing process in which it is expected that eventually no back up from the Digi PM responsible/expert will be needed.	Expert DigiPM Project manager

Experience of the learning process

1. Difficulty differs by person

Statement interview	Explanation of result	Perspective
”I think for some people it’s harder than for others. I think it has something to do, like if you’re more into like this technical things and if you have, like this thinking about data and how data works.” *Interviewee 2*	How difficult learning the new software tools and system is perceived by users depends partly on how technically skilled someone is.	Expert DigiPM
”For me, it was quite easy because I knew them from a from the very beginning. But then you have new people in the project. You have to train them, and that’s an ongoing process the whole time. Then there are older people which aren’t that firm with the software, we are using now.” *Interviewee 3* ”especially young people, who are very familiar with digital tools, should use it, and should also report it to our clients. Because sometimes they are older, our clients, and they are like, ohh digital can I not print it out?” *Interviewee 8*	Whether someone has worked with the software tool or something similar before certainly affects how well and quickly someone picks up the change. It appears that this change and learning the new systems is handled less quickly by the somewhat older people within the organisation.	Project lead

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2. Trial and error

Statement interview	Explanation of result	Perspective
”I think people in my age and also the the younger people, it’s not like learning it. It’s just doing it. It’s easy because it’s very familiar” *Interviewee 8* ”I think it was just the good old, learning by doing,” *Interviewee 5*	Because there is a certain recognition in the new software tools, learning is mainly by trying and just getting started with the system.	Project lead Project manager

3. User training

Statement interview	Explanation of result	Perspective
”for the tools, we had some learning’s. Uh, training’s like that, one hour, or two hours like that.” *Interviewee 3* ”There was like a little academy offer. So, we had like a meeting with everyone in our team for two hours, they explained it to us, and then it was learning on the job,” *Interviewee 8*	For the software tools, training sessions were available at the beginning of implementation at a project. After this, there was the intention to start working with them yourself.	Project lead
”There are some learning nuggets online. You can just look it up. So, if you have a very special question, you can just see a video or whatever.” *Interviewee 8* ”we have like the VIMA, how you say that? Wait. OK, knowledge management, knowledge centre? I don’t know. In our Intranet. So, you, yeah, you can use that as well. They have like nice guides to how to set up a project there, how to set up your structure and stuff.” *Interviewee 2*	To teach themselves to work better with the new system and software tools during the project, lessons and information are available on the organisation’s platform. These are offered for each tool.	Expert DigiPM Project lead

4. Expert involvement

Statement interview	Explanation of result	Perspective
”But often you ask the different competences for cost, and for time management, and for risk management, and they will help you as well, yeah.” *Interviewee 2* ”I have a very good connection to these tools guys here at our office. So, if I have a certain question or something, I would just go to them and and quickly ask them and go on their nerves.” *Interviewee 6*	There are several people within the organisation who are competence leaders for a particular software tool. These can always be reached for questions about this particular software tool.	Expert DigiPM Project lead
”we have one responsible person from the Digi PM for our project, which we always can ask when something doesn’t work.” *Interviewee 3* ”So, like implement this these things, and of course offer them that if they have any questions, they can always ask me.” *Interviewee 7*	For questions about the process or the system, users can always contact their assigned Digi PM responsible/expert. This is felt to be reassuring.	Project lead Expert DigiPM /Project manager

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5. Open for change

Statement interview	Explanation of result	Perspective
”And especially young people, who are very familiar with digital tools, should use it, and should also report it to our clients. Because sometimes they are older, our clients, and they are like, ohh digital can I not print it out.” *Interviewee 8* ”I’m very young, right. So it’s kind of natural that I always want to do the new stuff, see what’s new, and try different things.” *Interviewee 6*	It is perceived that the younger people pick up the transition more easily and are more open to it than the older people. This is because they prefer to stick with the old ways.	Project lead

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