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Managing Multiple Project Management Information Systems

A Case Study of a Swedish Manufacturing Company

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by

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Master of Science Thesis TRITA-ITM-EX 2023:254
KTH Industrial Engineering and Management
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Hantering av flera informationssystem för projektledning

En fallstudie av ett svenskt tillverkningsföretag

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Abstract

Project Management Information Systems (PMIS) play a critical role in supporting project outcome. However, little attention has been paid to the impact of having multiple PMIS while governing projects within organizations. This thesis explores the effects of the presence of multiple PMIS at a large manufacturing organization. The study used a qualitative approach, including interviews with Managers, IT Department and Senior Management as well as observations and an analysis of organizational documents. The data collected was analyzed using a thematic analysis approach. The findings revealed that the presence of multiple PMIS within the organization resulted in several challenges, including data inconsistency, duplication of effort, detrimental effects on the user experience and difficulty in managing the complexity of the PMIS landscape. However, the study also identified several potential benefits of having multiple PMIS, such as improved functional flexibility, customizability and enhanced project monitoring. The study recommends that organizations carefully consider their PMIS strategy, including the integration of different PMIS and the training of project teams on their proper use, to ensure that the effects of utilizing multiple PMIS are adequately addressed. Nevertheless, the study also recommends several areas for future research, including the exploration of the role of PMIS in project governance, the impact of emerging technologies on PMIS, and the examination of the impact of PMIS on organizational culture and behavior. Overall, this study highlights the importance of carefully managing the PMIS landscape within an organization to ensure its effectiveness in supporting project outcome and organizational efficiency.

Key-words: Project Management, Project Management Information Systems (PMIS), Information Systems, Organization, Project Outcome, Complexity, Information Scattering, User Experience

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Sammanfattning

Projektledningsinformationsystem (PMIS) har en avgörande roll för att främja projektslutresultat. Trots detta har det ägnats väldigt lite uppmärksamhet åt betydelsen av att tillämpa flera PMIS inom en organisation. Denna avhandling utforskar effekterna som uppstår av att flera PMIS är närvarande inom ett stort tillverkningsföretag. Studien har tillämpat en kvalitativ metodik som omfattar intervjuer med chefer, IT-avdelningen och högsta ledningen, samt observationer och en analys av utvalda interna dokument. Den insamlade datan analyserades med hjälp av tematisk analys. Resultaten av studien påvisade att närvaron av flera PMIS inom organisationen ledde till ett flertal utmaningar, såsom inkonsekvent data, dubbelarbete, negativ påverkan på användarupplevelsen och svårigheter att hantera komplexiteten av PMIS-systemen. Studien identifierade även flera potentiella fördelar som PMIS bidrog med, såsom ökad funktionell flexibilitet, anpassningsbarhet och förbättrad övervakning av projektens framsteg. Studien rekommenderar att organisationer noggrant överväger sin PMIS-strategi med avseende på integrationen av olika PMIS, samt utbildningen av projektteam för korrekt användning av systemen. Studien rekommenderar även flera områden för framtida forskning, inklusive utforskning av rollen som PMIS har inom projektstyrning, konsekvenserna av framväxande teknologier för PMIS samt undersökning av påverkan som PMIS har på organisationskultur och beteende. Sammantaget betonar denna studie vikten av att noggrant hantera PMIS-landskapet inom en organisation för att kunna säkerställa systemens effektivitet i att stödja projektslutresultat och organisationers effektivitet.

Nyckelord: Projektledning, Projektledningsinformationsystem (PMIS), Informationsystem, Organisation, Projektresultat, Komplexitet, Informationspridning, Användarupplevelse

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List of Abbreviations

IS	Information System
IT	Information Technology
PM	Project Management
PMIS	Project Management Information Systems

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Oskar Aazar & Simon Gamdrup
Stockholm, June 2023

1. Introduction

This chapter aims to provide the reader with an understanding of the context and background of the thesis. The problem statement is then formulated by identifying a gap in the literature where the effects of using multiple PMIS has not been adequately addressed. The purpose and research question are then presented, which aim to explore this gap empirically at a company within the manufacturing industry in Sweden. Thereafter, the significance and contributions of the study are presented. Finally, the chapter will discuss the delimitations of the study to clarify its scope and limitations, followed by a disposition of the thesis.

1.1 Background

Imagine a large manufacturing company embarking on a new project with multiple teams spread across different departments, each utilizing a combination of Project Management Information Systems (PMIS) to manage their respective tasks. As the project progresses, system dependencies and the amount of information processed between PMIS increases, making it increasingly difficult to track progress, monitor resources, and ensure timely completion of tasks.

When companies manufacture complex products, it is considered essential that the production involves significant planning, coordination, and execution across multiple functions, departments and teams to achieve the desired output (Davies et al., 2011). In order to effectively produce complex products, the operations are deemed well-suited to be governed as projects which is typically comprised of several phases, such as pre-production bidding, conceptual and detailed design, fabrication, delivery and installation, post-production innovations, maintenance, servicing, and ultimately, de-commissioning (Davies & Hobday, 2005). By utilizing a project-based approach to manufacturing, this task becomes easier to manage and is done as a temporary endeavor aimed at creating a unique product, service, or result, and they ensure effective resource allocation, timely delivery, and maintenance of quality standards (Project Management Institute, 2023).

Managing projects is viewed as a discipline consisting of planning, organizing and controlling resources to achieve predetermined objectives and goals within a specified timeframe and budget (Project Management Institute, 2023). Consequently, it involves

applying relevant knowledge, skills, tools and techniques throughout the duration of the project (ibid). Project Management (PM) is considered a necessity when manufacturing complex products as projects (Kerzner, 2017), since the manufacturing company requires input from specialized departments and teams, to ensure that the collective efforts are coordinated in alignment with the objectives of the project (Gray & Larson, 2018). Effectively, solid PM practices can provide significant benefits for the organization (Kerzner, 2017) under the assumption that the progress of the project is adequately monitored and efforts being adjusted along the process (Verzuh, 2021). Ultimately, by utilizing effective PM practices, the manufacturing processes can be optimized in a way that satisfies the customer needs (Geraldi et al., 2011). The contemporary state of PM practices is heavily influenced by the usage of IT-based information systems, often referred to as PMIS (Raymond & Bergeron, 2008).

PMIS aim to enable project managers to plan, execute and control project activities efficiently (Raymond, 1987; Cleland & King, 1983) and are considered to play a crucial role in effectively facilitating PM practices when in complex environments (Kerzner, 2017). Nonetheless, in a complex environment where real-time information on status of project activities, resources, schedules and costs are required, PMIS can allow project managers to make informed decisions and take corrective actions as needed (Raymond & Bergeron, 2008). The need for timely informed decisions is particularly important in large organizations that work in a field of complexity and within this setting, the benefits of using PMIS are well-documented (Lee & Yu, 2012; Mehta et al., 2016; Ogero, 2014; Raymond & Bergeron, 2008).

1.2 Problem formulation

However, despite the growing use and implied importance of PMIS in large organizations, there is a lack of understanding of the complexity and challenges caused by the presence of multiple PMIS. While studies have examined the impact of utilizing PMIS as a general concept, the research investigating the impact of explicitly using multiple PMIS is very limited (Raymond & Bergeron, 2008; Ahlemann, 2009, Kaiser & Ahlemann, 2010; Winter et al., 2006). As IT developments are made, an increasing amount of PMIS are available to businesses (Kostalova et al., 2015) and therefore multiple PMIS might be present in an organization. Due to the lack of research within empirics, the usage of multiple PMIS might

have an opposite effect, rather than being an effective supporting tool which facilitates projects.

1.3 Purpose

The purpose of this study is to explore the effects caused by the presence of multiple PMIS empirically in an organization.

1.4 Research question

The research question for this study is:

- How does the use of multiple PMIS affect organizations?

This research question aims to investigate the impact of using multiple PMIS and to provide insights into the complexities, challenges and opportunities associated with the use of multiple PMIS.

1.5 Significance and Contribution

The significance of this research lies in its contribution to the field of project management. The study contributes to the literature on project management, specifically in the area of PMIS, where contemporary research has insufficiently addressed the empirical use of multiple PMIS and the effects it has on the organizations that adopt it. Additionally, the study provides recommendations for large organizations on how to manage the use of multiple PMIS effectively. The findings of this research will mainly be useful for project managers, system developers and executives in large organizations.

1.6 Delimitations

This study focuses on a single case study of a large manufacturing organization in Sweden, referred to as Company X throughout this thesis. The study is delimited to investigating multiple PMIS at Company X. Therefore, the findings and conclusions of this study cannot be generalized to other industries or organizations without further consideration.

Furthermore, this study is limited to qualitative data collection and analysis. Data is collected through semi-structured interviews with key stakeholders involved in project management processes and document analysis, which may not capture all aspects of the phenomenon

under investigation. Additionally, the study is limited to the perspectives of the key stakeholders involved in the project management processes of Company X, which may not represent the views of all employees.

1.7 Report disposition

Chapter 2 - Literature	This chapter gives insight into the literature used to shape the study, both in terms of theoretical concepts and in relation to contemporary research within the theoretical field. This leads up to a presented gap among existing literature.
Chapter 3 - Methodology	The Methodology chapter presents and discusses methods that have been used to facilitate the study. This chapter includes guiding principles for important aspects of the study, such as the case description, literature review, research design, data collection, data analysis and considered factors that contribute to the quality of research.
Chapter 4 - Results and analysis	In this chapter the empirical findings are presented and analyzed based on the coding of data. This includes findings from interviews which contribute to answering the research question.
Chapter 5 - Discussion and recommendations	Here the empirical findings are discussed in relation to the literature gap and the research question to draw conclusions in order to deduce recommendations based on the empirics of the case.
Chapter 6 - Conclusion	Finally, the thesis is concluded by presenting the final outcomes of the thesis.

2. Literature Review

This chapter introduces relevant literature regarding the history of PMIS as well as the contemporary state of PMIS. Additionally, the effects and usage of PMIS is exemplified and put into empirical context to support the empirical analysis. Ultimately, a research gap is deduced from existing literature, which warrants and serves as the foundation to the aim of this study.

2.1 Project Management Information Systems (PMIS)

PMIS have been studied since the late 20th century, but the field remains incomplete due to its close connection to the ever-evolving world of information technology (IT). Initially, IT-based information systems were considered to be vital to the evolution of PM practices, as they could avail project managers in tasks of planning, organizing, controlling, reporting and decision-making (Raymond & Bergeron, 2008; Jaafari & Manivong, 1998). The general concept of the PMIS was an efficient supporting tool that would assist project managers in attaining project objectives and to implement strategies for projects (Raymond, 1987; Cleland & King, 1983). What differentiated a PMIS from an arbitrary information system (IS), was that a PMIS needed to be more customizable than an IS by also continuously being adaptable to meet the needs of project requirements (Kaiser & Ahlemann, 2010; Teixeira et al., 2016). Furthermore, when PMIS emerged, it quickly gained traction as it showed prominence with project managers. Introducing and successfully utilizing PMIS in their projects led to improvements in effectiveness and efficiency in managerial tasks, which enabled the continued use and development of PMIS as an integral tool within PM practices (Raymond & Bergeron, 2008).

The concept of PMIS as a PM supporting tool has undergone development from single-user and single-project management systems to the contemporary state where PMIS are complex, multi-functional systems (Ahlemann, 2009). These systems cover functions that are much more encompassing than just project planning and resource management, where they now support the entire life-cycle of projects and project portfolios according to corporate needs (Ahlemann & Backhaus, 2006; Braglia & Frosolini, 2014).

When contextualized, modern PMIS are often realized through software packages that are integrated to meet the organization's needs (Raymond & Bergeron, 2008). While modern

PMIS still revolves around the same basic functions, being communication, collaboration and sharing, the tools to achieve these tasks can be as complex as software developers allow (Lee & Yu, 2012). In addition to these basic functions, PMIS must effectively collect, organize, store and process project information. In recent times, numerous PMIS have emerged, offering commercial solutions or being internally developed by businesses (Kostalova et al., 2015).

A PMIS could be exemplified by Microsoft 365 applications such as Teams and SharePoint for planning, scheduling, document management, and collaboration (Mehta et al., 2016), which provide advanced solutions to support portfolio management with a comprehensive range of features and the ability to customize according to the user's needs (Kostalova et al., 2015). Another exemplification of PMIS is JIRA, which provides issue tracking, customizable workflows and agile project management (Mishra & Mishra, 2013; Kaidalova et al., 2018). Moreover, PMIS are often divided between solutions that can be cloud-based or stand-alone applications stored on centralized servers (Braglia & Frosolini, 2014; Kostalova et al., 2015). Cloud-based applications are often offered by external parties which provide generalized PMIS (Braglia & Frosolini, 2014), while other PMIS are often produced in-house by corporations to better fit their functional needs (Jaafari & Manivong, 1998; Wu & Hsieh, 2012).

2.2 Effects of PMIS

Several studies have investigated the relationship between PMIS and project outcome (Raymond & Bergeron, 2008; Ahlemann, 2009, Kaiser & Ahlemann, 2010; Winter et al., 2006), mostly from a theoretical or quantitative perspective. Through quantitative analysis, a general consensus has emerged that PMIS are valuable to improve project outcome and a correlation between the two shows that the connection is of significance (ibid). Among the benefits of PMIS, budget control and ability to meet project deadlines is shown to be enhanced (Raymond & Bergeron, 2008). Additionally, it is emphasized that the outcome is influenced by productivity which is heavily attributed to user satisfaction of the PMIS (Nguyen et al., 2016; Lee & Yu 2012).

Apart from the dimension of project outcome being enhanced by PMIS, the dimension of efficiency within projects is also a focal point of conducted research. Efficiency is measured

by the rate of actual work performed, which is improved by cumulative experience of usage within the PMIS (Pellerin et al., 2013). Conclusively, by increasing usage time within the PMIS, the efficiency for the project increases (ibid). Project managers also appear to be more inclined to adopt PMIS when they are free of complexities (Caniëls & Bakens, 2012; Raymond & Bergeron, 2008), where complexities lead to confusion on how and why they should perform their tasks (Caniëls & Bakens, 2012).

Effectiveness of projects can also be measured in time and scope of projects, where PMIS has proven to be influential to these factors under the assumption that users have experience or training within the PMIS (McCarty, 2012; Thomas & Mullaly, 2008; Retnowardhani & Suroso, 2019). Nevertheless, the user's perception of the system, as in how well it supports their work, might make them reluctant to adopt the system (DeLone & McLean, 2002; Saeed & Abdinnour-Helm, 2008). Careful planning and execution of training and monitoring activities are crucial to address the challenges that users frequently encounter due to insufficient training when working with systems (Pellerin et al., 2013).

While the general importance of PMIS has been established, several researchers imply that the field does not adequately consider the level of complexity needed to accommodate growing project, system and organizational complexity (Ahlemann, 2009; Saeed & Abdinnour-Helm, 2008; Raymond & Bergeron, 2008; Caniëls & Bakens, 2012; Kaiser & Ahlemann, 2010). Despite its practical and theoretical importance, the practical use and application of PMIS has sparsely been studied (Winter et al., 2006). Furthermore, conducted research rarely considers the fact that PMIS are becoming increasingly complex as they include a growing number of business processes (Ahlemann, 2009). As the amount of PMIS increases, this would include businesses using multiple PMIS, in modern applications, to incorporate more processes which necessitates integration and compatibility with other systems.

2.3 Presence of multiple PMIS

The literature seldom mentions PMIS in a context that evaluates the use of multiple PMIS to handle business processes. On the contrary, it is described by function or is studied within the confinement of generalized or a single application (Raymond & Bergeron, 2008; Ahlemann, 2009, Kaiser & Ahlemann, 2010; Winter et al., 2006). Through the previously mentioned

literature, it has been argued that PMIS in general are beneficial to project outcome and efficiency. However, factors attributed to the presence of multiple PMIS when conducting a project have not explicitly been discussed. It is possible to assume that the benefits of using PMIS in general are applicable to the case of multiple PMIS, but complications may yet arise.

While the success of implementing PMIS in order to enhance project outcome is heavily reliant on the effectiveness and perception of the user (Lee & Yu, 2012; Raymond & Bergeron 2008), the effects of utilizing multiple PMIS can be assumed to be magnified as more systems provide more functional capability and can encompass a larger area of utilization. However, these findings would correspond with an assumption that the multiple PMIS are well integrated and compatible for utilization in order to facilitate the purpose of use. Therefore, if the assumption does not hold true, using several PMIS may create unwanted effects. As the success of using PMIS is reliant on measures of user adoption and perception of the systems, adding more PMIS might also prove to increase perceived complexity. Due to potential system redundancy and inconsistencies, users might struggle to use several systems compared to fewer ones and this could increase the competence and management requirements of users in order to effectively utilize the multiple PMIS for their intended purpose. Additionally, if PMIS are unable to communicate information amongst themselves, this might further add pressure on the user to manually operate the information flow between the systems. Drawing further on this speculation, unknown complications or benefits could arise due to the presence of multiple PMIS.

2.4 Research Gap

Despite the numerous studies on the effects of using PMIS, there is a gap in the literature regarding the presence of multiple PMIS within an organization. While studies have examined PMIS in quantitative settings or as a general concept, they have overlooked the complexities within organizations and systems caused by the presence of multiple PMIS. Moreover, the presence of multiple PMIS might require careful planning, technical expertise, communication, coordination, and change management.

Conclusively, there is a lack of consensus on the optimal number and combination of PMIS to use in different contexts. Organizations need insights into the effects caused by the presence of multiple PMIS to support and improve project management practices.

3. Methodology

In this chapter, the research methods employed in the study are outlined. This includes a description of the case, literature review, research process design and data collection procedures. Additionally, the evaluation of the research process's reliability, validity and generalization is addressed, along with ethical considerations related to the study.

3.1 Case description

Company X is a division of a large global organization, specializing in the development and manufacturing of advanced machinery for power generation. With a strong focus on technological innovation and sustainability, the organization has established itself as a global leader in the energy sector. Company X undertakes numerous complex projects that require efficient project management and coordination across various departments and stakeholders, operating with a matrix organizational structure.

Recognizing the need for effective project management and collaboration tools, Company X implemented multiple PMIS to support its project operations. The PMIS adopted by the company encompass various software tools and platforms tailored to specific project management needs. These systems include project scheduling software, document management systems, communication platforms, and reporting tools. The selection of PMIS was driven by the diverse requirements of different projects and aimed to enhance project efficiency, communication, and decision-making. Notable examples of the systems utilized by Company X include PMIS 1, PMIS 2, and PMIS 3.

PMIS 1 is a comprehensive project scheduling and resource management software that allows project managers to create and manage project timelines, allocate resources, and track progress. It provides a centralized platform for project teams to collaborate, update task statuses, and monitor project milestones.

PMIS 2 is a robust document management system utilized by Company X. It enables the secure storage, retrieval, and sharing of project-related documents and files. With features such as version control and access permissions, PMIS 2 ensures document integrity and facilitates effective document collaboration among team members.

PMIS 3 is a communication and collaboration platform that fosters real-time communication and information sharing among project teams and stakeholders. It offers features such as chat functionalities, discussion boards, and virtual meeting capabilities. PMIS 3 facilitates efficient and transparent communication, ensuring that project teams stay connected and informed throughout the project lifecycle.

3.2 Literature review

In this study, the four-phase process of conducting a literature review described by Snyder (2019) was used. The process involved designing, conducting, analyzing, and writing the review.

The first phase of the review involved designing it, which included determining the purpose of the research and the approach that would be suitable for the case.

The second phase involved collecting all relevant articles and conducting the review in stages. The articles were first filtered through titles and abstracts to check for relevance, and then sorted by reading the full text. Due to time constraints, this approach was deemed the most suitable for this study. The articles were collected through Web of Science, Scopus and Google Scholar using search queries and keywords to obtain a narrow and in-depth understanding of the literature in the field.

The third phase involved analyzing the literature with an appropriate method. After analyzing the articles, the results were combined to gain a general understanding of the research subject.

In the fourth and final phase, the results of the review were presented. Snyder (2019) emphasizes the importance of transparency in the review process and how the articles were collected for the validity of the review. Figure 3.1 provides a graphical overview of the method followed in the review along with the amount of publications extracted from each phase.

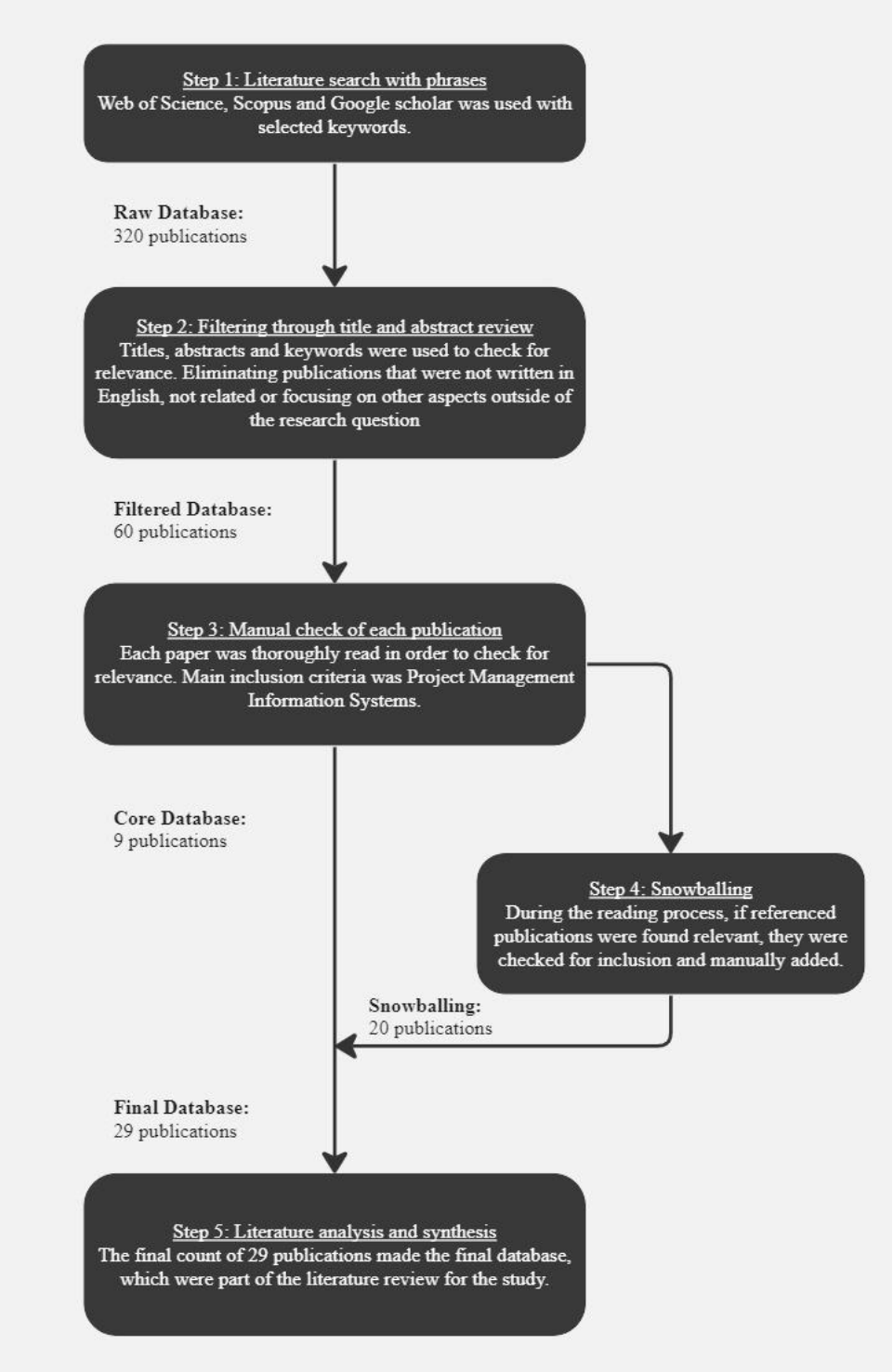

Figure 3.1: A graphical overview of phase 2 and 3 in the process of the literature review.

3.3 Research design

The complexity of the research question and problem under investigation necessitated a research design that was extensive, broad and clearly defined to ensure the delivery of study results and the proposal of viable solutions and conclusions. As such, the research design

utilized a qualitative approach to collect data from interviews, documents and observations, mainly consisting of non-numerical data and information, employing an exploratory approach to answer the research question.

The data collection process combined both deductive and inductive approaches, consisting of a literature pre-study, interviews and revision of internal documents. The research design adopted an abductive approach (Saunders et al., 2016) to generate theory by using data to explore a phenomenon, identifying themes, and explaining patterns to create a new or modify an existing theory, often through additional data collection.

Given the nature of the problem under investigation, a case study approach was employed, which according to Yin (2003) is appropriate for answering 'how' questions and for covering contextual conditions that are relevant to the phenomenon studied. The case study approach provided an in-depth understanding of the phenomenon in its real-life context, leading to empirical description and potential development of theory (Baxter & Jack, 2015). This study adopted a single case study approach due to the privileged access granted by the case company, and the data collection procedures and methods were described in detail to ensure analytical generalizability.

3.4 Data collection method and procedure

This section details the data collection methods employed in this study, which align with a case study approach. Various sources were utilized to gather data, see Table 3.1.

Table 3.1: Summary of empirical data gathered.

Data collection method	Type of data	Data quantity (interviews, documents, etc.)
Semi-structured interviews	Total interviews, including:	21 interviews
	IT-Department	6 interviews
	Managers	7 interviews
	Senior Management	8 interviews
Observations	Total time of observations, including:	70+ hours

	Meetings	10 meetings
	Workshops	4 workshops
	Informal observations	30+ hours
Documents	Total documents:	15+ documents

3.4.1 Interviews

The study utilized interviews as a major data collection method to gather information related to the study. The primary objective of the interviews was to gain insight into the context of the problem and identify its nature and features.

To conduct the interviews with the case company, the researchers communicated with current project managers within the company to facilitate contact with key individuals from different stages of projects. A small-scale mapping of projects was created to identify project members from various parts of the projects. The selected interviewees were invited through email, providing them with information regarding the inquiry and the intended usage of the material. The interviews were conducted digitally and were recorded for transcription purposes with given consent.

In order to ensure the quality of the interviews, both the researchers were present during each interview. This allowed for an unbiased discussion and ensured that the expected quality standards were upheld. The researchers prepared questions before the interview to encourage an open discussion, with a focus on obtaining the most relevant information and exploring uncharted areas of knowledge within the projects. Therefore, the interviews were semi-structured.

It was deemed valuable to interview a range of individuals, who have experience with the systems and their implementation, to gain a comprehensive understanding of the use of PMIS at Company X. The potential groups of individuals that were considered for the interviews were Managers, IT Department and Senior Management.

Managers were considered as these individuals are likely the primary users of PMIS within the organization. By speaking with managers, insights were gained into how they use the

systems in their day-to-day work, the benefits and challenges they have experienced, and how the systems impact the organization.

IT departments were considered since the IT departments are responsible for implementing and maintaining the PMIS. By interviewing members of this department, insights were gained into the technical aspects of the systems, such as how they were customized for the organization, how they were integrated with other systems, and how they were secured, all of which contribute to the collective understanding of how the systems might affect the organization.

Senior Management was considered since senior managers may have a broader perspective on the implementation and use of PMIS within the organization, as well as the strategic objectives that the systems are intended to support. By interviewing senior managers, insights were gained into the rationale for implementing PMIS, how they fit into the overall strategy of the organization, and how the system's effectiveness is measured.

Overall, it was deemed ideal to interview individuals from different levels of the organization, as well as those with different perspectives on the use of multiple PMIS, in order to gain a well-rounded understanding of the system's effects at Company X. A total of 21 people were interviewed, see Table 3.2.

Table 3.2: Detailed view of interview subjects within Company X.

Name	Category	Role	Length	Date
Subject A	IT Department	Automation Processes	45 min	March 2023
Subject B	IT Department	Business Support	55 min	March 2023
Subject C	IT Department	Technical support	60 min	April 2023
Subject D	IT Department	Technical Analyst	60 min	April 2023
Subject E	IT Department	Process Professional	50 min	April 2023
Subject F	IT Department	Technical support	30 min	April 2023
Subject G	Manager	Project Manager	55 min	April 2023
Subject H	Manager	Project Manager	45 min	April 2023

Subject I	Manager	Project Manager	30 min	April 2023
Subject J	Manager	Project Manager	30 min	April 2023
Subject K	Manager	Project Manager	50 min	April 2023
Subject L	Manager	Project Manager	50 min	May 2023
Subject M	Manager	Strategic Advisor	40 min	May 2023
Subject N	Senior Management	Head of Department	60 min	March 2023
Subject O	Senior Management	Head of Department	50 min	April 2023
Subject P	Senior Management	Head of Department	60 min	April 2023
Subject Q	Senior Management	Head of Department	45 min	April 2023
Subject R	Senior Management	Head of Department	35 min	April 2023
Subject S	Senior Management	Head of Organization	45 min	April 2023
Subject T	Senior Management	Head of Organization	65 min	April 2023
Subject U	Senior Management	Head of Organization	55 min	April 2023

3.4.2 Documents and observations

Throughout the research process, documentary research has been conducted in accordance with the qualitative nature of the methodology. The documents collected have played a significant role in the empirical segment of the study, particularly in contextualizing the case company and its situation.

The collected documents were retrieved from the case company and encompassed technical, organizational, and business-specific information related to their projects. The documents proved useful in gaining initial insight into the case company, its projects and its challenges during different phases of the projects. Additionally, they provided a foundation of data for the research process, complementing other data collection methods.

A large portion of time was spent at Company X making direct observations through meetings, workshops and informal interactions on site. Supplementary information regarding the content of the documents was discussed in post-meetings with the case company. Hence,

the information gathered from meetings was also utilized in the study. These meetings were categorized as presentations and discussions with the case company.

3.5 Data analysis

This section outlines the coding procedure and methodology used in the study. The study employed recorded and transcribed interviews as data sources, with a focus on answering the research question.

The coding procedure utilized an inductive approach, with codes being defined based on the material, rather than a predefined framework (Cope, 2010). The codes mainly focused on the effect of utilizing multiple PMIS. The recorded and transcribed interviews were reviewed in the first cycle for themes that could be used to develop reasoning for answering the research question. These themes were then defined into codes, which were used to record their appearance in all collected interviews.

The codes were assigned unique descriptions and justified based on their relevance to answering the research question (Mihas, 2019). Finally, the codes were discussed and conclusions were drawn regarding their importance, weighted by their contents and appearance in the recorded and transcribed interviews. The data collected were used in the coding procedure with a content analysis built upon these sources through a codebook.

For this study, four themes of codes have been developed. The developed themes were deemed suitable to answer the RQ as they provide different nuances and perspectives of the effects that occur due to the presence of multiple PMIS. The themes focused on are:

1. **Information**

   The theme explores the effects related to the information that is being managed in the PMIS by Company X. In order to understand the effects of PMIS, it is necessary to analyze the information that is flowing within the systems as it utilizes the functionality of the PMIS and may amplify the effects of the systems further. By studying the information, more detailed insights can be gained into the effects that PMIS has on the organization. This included aspects such as information processing and storing, quality of information and risk for errors.

2. **Systems**

   The theme relates to the effects of the use of multiple PMIS in Company X from a technical perspective. It is important to analyze the effects from a technical perspective since PMIS is an IT-based tool, where the effects of multiple PMIS can be assumed to have a strict correlation to the efficiency of the system itself. This included aspects of analyzing utilization, implementation, synchronization, complexity and compatibility of using multiple PMIS.

3. **Users**

   The theme relates to effects of PMIS on the users at Company X. To gain further insight into the effects that multiple PMIS has on an organization, the users that operate the systems should be considered as a separate unit of analysis, as they are an important stakeholder in the organization. This included aspects such as user perception, user adoption, way of working, education and risk for errors.

4. **Governance**

   The theme relates to the effects associated with the governance of multiple PMIS at Company X. By understanding the governance of multiple PMIS, additional insights can be granted to the reasons of why certain effects occur, but also aids in identifying effects that are a direct cause by certain governing practices, all of which contribute to understanding the organizational effects of using multiple PMIS. This includes aspects such as cost, maintenance, internal politics and confidentiality.

3.6 Quality of research

When conducting a study, presenting results of value is the product of establishing the processes and quality of the research. Therefore, validity, reliability and generalizability of the study were considered when evaluating the quality of the research (Blomkvist & Hallin, 2015).

3.6.1 Validity

Validity is the concept of studying the appropriate elements, and were attained by ensuring that the literature review, analysis theory, and data collection methods were relevant to the research problem and subject field, and that the discussions were connected to the study's purpose (Blomkvist & Hallin, 2015). To maintain a high level of validity, a suitable research design and validation methods were employed throughout the research process (Saunders et

al., 2016). The validation methods used included participation validation and triangulation. Participation validation was deemed important to assess the quality and credibility of findings and was achieved by allowing interview participants to review the final report and interview transcripts, which opened up the possibility to verify and clarify any interpretations made. Triangulation was considered to confirm validity, which was done by using multiple data collection methods and independent sources.

3.6.2 Reliability

Reliability, as defined by Blomkvist & Hallin (2015), involves "studying the right thing in the right way", and is related to the consistency and replicability of a study (Saunders et al., 2016). To ensure transparency and disclosure of methodology, both internal and external reliability measures were taken in this study.

Internal reliability measures included having both researchers participate in interviews to minimize misinterpretations and bias. Analysis of data and coding of interviews were also performed by both members of the author team to ensure accuracy and credibility. External reliability measures were taken to minimize research errors and bias, such as the use of standardized interview template for all interviews and recording interviews to aid analysis (Saunders et al., 2016).

To reduce participant bias and error, efforts were made to ensure anonymity and provide interviewees with the questions beforehand to familiarize themselves with the material and study context. These measures aimed to encourage participants to freely share valuable information.

It should be noted that the semi-structured nature of the interviews may have decreased reliability, but the use of standardized templates and recording of interviews aimed to mitigate this risk.

3.6.3 Generalizability

The concept of generalization refers to the extent to which the results and findings of a study can be applied to other contexts, which is also known as external validity (Saunders et al., 2016). Since the research design used in this study is a case study approach, achieving

statistical generalizability is quite challenging as the empirical data differs from case to case (Blomkvist & Hallin, 2015). Nevertheless, efforts have been made to ensure analytical generalizability in the study.

In addition to the case study approach, the study has been conducted systematically to increase analytical generalizability. This was achieved through the establishment of the research design, the data collection methods, and the analysis methods, which were all clearly defined and justified. As a result, all the research methods used in this study have been accounted for and discussed in this chapter. Furthermore, chapter 6 provides a discussion on the generalization of the study's findings.

3.7 Ethical considerations

Since engaging in academic research, it was deemed crucial to consider ethical factors. Research ethics involved not only the research itself, but also the researcher's personal conduct and behavior (Vetenskapsrådet, 2017). Therefore, adopting an ethical approach was deemed important in the research process.

The Swedish Research Council (2017) has established ethical codes by outlining four research requirements that researchers should adhere to in order to ensure good research practice. These requirements include the information, consent, confidentiality, and good use requirements. This study has made efforts to comply with these requirements to ensure good research practice. This has been achieved through transparency in the methodology processes and by reviewing and reporting the study's objectives. The following paragraphs describe how the study adhered to these requirements.

The information requirement involves informing all participants in the study of its purpose (Vetenskapsrådet, 2017). To comply with this requirement, the purpose and scope of the study were explained to interviewees during multiple phases of contact. The purpose was provided at the beginning of each interview, as well as through email or similar when initiating contact. This was done to be as transparent as possible and to provide participants with a clear understanding of the study. Additionally, participants were provided with the questions that would be asked in advance to give them further insight and understanding of the study's context, as well as the researchers' role and aim.

The consent requirement states that anyone being studied must give their consent to participate (Vetenskapsrådet, 2017). In this study participants agreed to participate under the terms provided during initial contact. Consent was also obtained during the interviews, where the researchers asked whether the participants consented to recording the interview. At the end of each interview, participants were given the opportunity to withdraw any information they felt was sensitive or confidential, ensuring their consent to share the information and data collected in the report.

The confidentiality requirement requires that any material collected during the research process be treated confidentially (Vetenskapsrådet, 2017). This was accounted for by ensuring that any documents provided by the case company were only included to the extent that they could be used ethically. Anonymity was also considered for the case company and interviewees to prevent potential harm to them or the study. This was ensured by keeping the interviewees and case company anonymous throughout the research process.

The good use requirement emphasizes that any collected material and data can only be used for the stated purpose (Vetenskapsrådet, 2017). All material collected during this study was erased once the course for which the study was conducted had ended, as it would have served its purpose. Any future studies would require new data collection.

4. Results and analysis

The results in terms of empirical findings from the study are presented within this chapter, where findings have been gathered from interviews, documents and observations. Results and analysis are presented from Information, Systems, Users and Governance themes.

4.1 Information

In this section, the results related to the information theme are examined. The analysis focused on investigating the effects of the processing and storing of information, the information's quality and the risk of errors of using multiple PMIS in an organization.

4.1.1 Information Processing and Storing

In order to make an assessment as to the effects of the presence of multiple PMIS, this dimension encompasses the effects of the inputs and outputs of PMIS usage which ultimately can be of value to the organization.

> *"Processing and storing project information in multiple systems simultaneously poses challenges, including data duplication and synchronization problems. This fragmented approach hampers gaining an overview of the data and leads to redundant work in locating the correct and latest updates" - Project Manager*

One of the key findings and central topics within the information theme is that utilizing multiple PMIS results in information being stored in several locations (Subjects O, Q & R). This study found that project information is no exception within the case company, and processing and storing this information in multiple systems simultaneously poses challenges (Subjects N, O, P & R). A significant issue with having information in multiple locations is that data tends to be duplicated across systems, leading to synchronization problems (Subjects P, Q & R). Updating duplicated data requires accessing the data in its original storage location, which can be cumbersome since users are sometimes unaware of duplicates that may exist (Subjects G, H, I & K). This may also create combined effects that cause difficulties in gaining an overview of the data (Subjects Q, S & U). Without a clear overview of the data, project managers and other users may struggle to utilize the information when needed, creating redundant work to locate the correct and latest updates of information

(Subjects I, J, N & R). Moreover, the project team or department as a whole may face challenges in planning and allocating resources, as compiling information from various sources can be time-consuming and inefficient (Subjects O, P & T). Additionally, working with many systems can lower the traceability of information, causing delivery delays and increasing stress among employees who rely on the information stored outside of the main systems (Subjects J, K & L).

"Compiling information from various sources due to multiple systems is time-consuming and inefficient, impacting resource planning and allocation for project teams and departments" - Project Manager

Finally, it is worth noting that working with the same information across multiple systems can result in users losing their understanding of why certain things are done, leading to a decrease in information quality and potential cascading complications (Subjects G, M & P). Reducing the number of systems used can improve the quality of information since compiling information in a single location becomes easier, making it more efficient to find and work with the information (Subjects B, C, D & G).

"Working with the same information across multiple systems can lead to a decrease in information quality and potential cascading complications. Streamlining systems and consolidating information in a single location can enhance information quality and improve efficiency in finding and utilizing the data" - Head of Department

4.1.2 Quality

The quality of information in PMIS is crucial since errors in quality could result in false assumptions on which project decisions are based. This aspect is particularly significant when examining the impacts of multiple PMIS, as it is assumed that strict quality standards are essential in any setting involving project-based activities.

"While Company X invests significant resources and time in improving information quality during the processing between systems, comparatively less attention is given to enhancing the systems themselves" - Head of Department

An effect of using multiple PMIS, when they do not have the same level of quality constraints, some systems allow its users to make fundamental errors while others have implemented safeguards (Subject D, H & R). A lack of guidelines within the systems was also found to deteriorate information quality and complicate the learning process, affecting work practices (Subject C, F, I, J & K). Storing information across multiple PMIS makes it challenging to maintain data quality, requiring the implementation of maintenance routines across all systems, which becomes increasingly complex as more systems are present (Subject B, E, N & R). Moreover, data quality tends to be better in frequently used systems, while rarely used systems often have poor data quality, magnifying the effect of infrequent users having difficulty detecting errors and updated information (Subject G, H, I & J). Since multiple systems are harder to maintain (Subject A, D & E), ensuring data quality within each system becomes an individual responsibility, resulting in a loss of cohesion and unwanted effects within departments, necessitating time allocation towards departmental meetings to address problems (Subject N, O, P, Q, & R).

"Storing information across multiple systems creates difficulties in maintaining data quality, particularly in rarely used systems where errors and outdated information may go unnoticed. As more systems are added, the complexity of implementing and ensuring data quality maintenance routines increases" - Head of Department

4.1.3 Risk for errors

In addressing the research question, it is essential to understand the potential risks and errors associated with the information flowing across PMIS, particularly those related to using multiple systems. The code deals specifically with the risks associated with information flowing across multiple PMIS.

"I have noticed that when utilizing multiple systems for storing and processing information, inconsistencies can arise across different systems. This can be attributed to a lack of synchronization or duplicated information, requiring diligent monitoring and verification efforts to ensure consistency" - Project Manager

Utilizing multiple PMIS to store and process information can result in inconsistent information being stored in different systems (Subject G, J, and L). This can be due to a lack

of synchronization between the systems or duplication of information, and it requires significant effort to monitor and verify consistency between systems (Subject G, H, I, J, K, and L). To reduce these errors, it is recommended to compile information in a single source, essentially having master data located in one location (Subject C, D, and F). In addition, errors can occur due to a lack of data quality, where data inputs could be incompatible with the systems, resulting in malfunctions that need to be manually addressed (Subject A, B, C, E, and F).

4.1.4 Summary: Information

Considering the aforementioned factors that indirectly affect a company when utilizing multiple PMIS in terms of the information that is processed within the systems, it can be concluded from this theme that the information needs to be treated vigilantly and ensuring that the correct information being used is essential. Table 4.1 presents an overview of the findings within the Information theme.

Table 4.1: Summary table of Information theme.

Code	Finding
Information Processing & Storing	- Stored and processed in multiple systems simultaneously, often causing duplicates and issues with synchronization
	- Updating information requires access to the origin and may be hard as users can be unaware that duplicates exist
	- Gaining an overview by compiling information can be time-consuming and inefficient use of resources
	- Issues with traceability and reliability stem from information being processed and stored in different locations
	- Reducing the amount of PMIS interacting with the information would alleviate many complications, but reduce the capacity of which the information can be processed in
Quality	- Lowered by scattering and duplication of information which can cause decisions to made under false pretenses
	- Multiple systems are harder to maintain, therefore responsibility to ensure quality is often attributed to individuals who process the information
Risk for errors	- Can often be attributed to lack of synchronization or duplication of information

4.2 Systems

This section will discuss the findings from the systems theme. When analyzing the systems theme the focal points were to study the impact of the use, implementation, synchronization, complexity, risk for error and compatibility of multiple PMIS.

4.2.1 Utilizing Multiple PMIS

This code relates to understanding the effects caused by utilizing multiple PMIS. It is important to understand how PMIS are utilized within the organization in order to draw conclusions in regards to the effects that it causes. Therefore, the details of how the systems are used provide valuable insights to identifying the complexities, challenges and opportunities that adopting multiple PMIS can provide to an organization.

"We do not utilize the full potential of the systems here at Company X" - Head of Organization

Like many other technical manufacturing firms, Company X relies entirely on systems to carry out its operations (Subject S). However, observations reveal that some ambiguity arises regarding which systems are best suited for certain operations. This ambiguity can partly be attributed to the added complexity of using several systems, as the systems need to be fully compatible with each other and readily usable for the systems' users. Subject A, G, and N corroborate this argument by stating that the full potential of the systems within Company X is rarely utilized, as they become too complex, and users prefer to use more straightforward systems to accomplish the same tasks.

"The system I engage with on a daily basis is an immensely potent and intricate system, of which I only utilize 5% of its complete capacity" - Process Professional

Another reason for why multiple PMIS might be beneficial for a company like Company X was revealed during observations and meetings, which is its connections with external suppliers. Since suppliers may have their own unique systems that require integration and compatibility with Company X's systems, the complexity and need for multiple PMIS are further enhanced. While this might seem like a complicating factor in relation to the effects of multiple PMIS, Subject T mentioned that having fewer systems does not necessarily make the

overall use less complex. It is stated that fewer systems would increase the requirement on the system itself to be more complicated so that it can satisfy all of the functional requirements and so that it can store and process all the information that flows through (Subject D, E, and T). In comparison to the previous statement about increased complexity of multiple PMIS, observations reveal that there seems to be a disagreement within Company X on whether using fewer or more systems would be the optimal solution to the problem. When trying to assess the situation and metrics of which alternative is preferable, Subject T mentions that it can be very difficult to measure due to the nature of the projects, and the fact that each project is unique, meaning that the configuration of systems might alter between projects.

"Typically, when collaborating with external suppliers, they often possess their own systems that necessitate integration with our own systems" - Head of Department

Although the perception of complexity is rather ambiguous within Company X, some interview subjects express concerns about using multiple PMIS in relation to synchronization and automation (Subject A, C, and E). A prevalent issue within Company X that is attributed to the presence of multiple PMIS is the creation of information duplicates, which has the causal effect of doubling the required work and consequently increasing project costs. Subject D provides an example in which two systems could be dependent on the same information, and in the absence of automation, double inputs would be required to transfer the information between the systems. Furthermore, in the lack of automation and synchronization, information tends to be scattered among several systems, which causes further complications (Subject B, C, and F). As information is scattered, there is no single source of truth, and the information within the systems lacks reliability and validity (Subject J, K, and L). As a result, observations reveal that users lose trust in the data and create duplicates due to ignorance of the information flow within the systems. This leads to a spiraling effect where more information duplicates cause more scattering and more scattering causes more information duplicates.

"An issue I encounter on a daily basis while working with dispersed information across multiple systems is the erosion of trust in the data due to the absence of a single truth of source" - Project Manager

Finally, based on observations, it has been noted that ownership of systems can be unclear or dispersed among departments that share the same systems. This can be attributed to infrequent use of a particular system, leading to ambiguity in interpretation and ownership (Subject N, P & R). The variations in work practices among departments can also contribute to the adoption of additional systems that are better aligned with their specific needs rather than optimizing an existing one (Subject P, Q & R). However, using the same system across multiple departments can result in decreased functionality for a particular department (Subject O, Q & R). This lack of optimization can lead to reduced productivity and output quality (Subject H, K & L). Although using more systems can increase functionality, it also requires more time to work within the multiple systems (Subject G, I & J).

"Within our organization, we employ diverse systems across different departments, resulting in infrequent optimization specifically tailored to meet the needs of my department" - Head of Department

4.2.2 System implementation

This code relates to the effects of implementing the systems in a multiple PMIS setting. The aspect of implementation is broad and can have many meanings, but in the context of the code, it relates to the effects of making the systems work and what happens when they are not used in their intended manner.

"At Company X, we rarely accommodate the systems to fit our needs, instead investing significant effort into making the systems function according to our desired specifications" - Head of Department

During several observation periods, it was observed that multiple PMIS require significant effort and resource allocation towards implementation and interviews corroborate that PMIS require active adaptation to fit existing processes (Subject S, T & U). However, it was also noted that when systems are not used in their intended manner complications from multiple systems and compatibility issues arise (Subject I, J & K). As a result, the organization has tried to align system use with existing processes and departmental guidelines (Subject P, S & U). Despite these efforts, the approach has not always been successful and has even had

negative effects on the workforce responsible for implementation and system utilization (Subject N, O & Q).

"Due to the intricate nature of certain systems, it is not uncommon to employ them in ways that deviate from their original purpose" - Project Manager

4.2.3 Synchronization

When utilizing multiple PMIS to process the same information, some form of synchronization is important to ensure that the information is updated through several systems. To optimize the utilization of multiple PMIS, it is essential to establish synchronization between these systems, which can be achieved either through manual efforts or automated processes. By delving into the various aspects of synchronization, it is possible to gain a deeper insight into the complexities and challenges that arise as a result of deploying multiple PMIS.

"My main goal when utilizing automation is to minimize unnecessary employee involvement with the systems, as it is the primary factor leading to the occurrence of errors" - Automation Processes

During the interviews, the topic of automation was discussed extensively, with the assumption that synchronization is necessary for efficient dissemination and processing of information within a large task force. Many interviewees expressed that an effect of automation between PMIS is the reduction of human errors compared to manual data entries (Subject A, C & F). The primary benefit of automation is that data updates across systems would be more consistent (Subject A, B, & E). However, interviewees also acknowledged that automation comes with its own set of challenges. It would require an exponentially increased effort to maintain, develop, and monitor the automated processes, which could be a significant hindrance when attempting to utilize multiple PMIS (Subject D, I & P). Subject N also pointed out that by relying on automated processes, project managers and users could lose insight into why their actions are being conducted, leading to a narrow scope of work. Therefore, the effects of automation need to be evaluated when using multiple PMIS.

"While automation may appear beneficial, excessive reliance on automated processes and employees solely working with individual data entries can result in a loss of understanding regarding the reasons behind their actions" - Head of Department

Based on observations and documented evidence, it appears that solely relying on preset routines in complex projects may not be the best approach for Company X. This is especially true for projects that require flexibility, as automated processes encompassing multiple PMIS would be difficult to modify during use, leaving little room for updates, bug testing, and maintenance (Subject A, D, and F). Moreover, when working with unique projects it can be challenging to create an automated flow that can satisfy all projects (Subject A, D, and E).

Reducing the level of automation in the information flow can help project managers and system users detect errors in the manufacturing stage before they reach the end of the manufacturing stages, resulting in reduced resource consumption (Subject G, R, and U). However, reducing automation may not always be feasible. Subject Q highlights that decreasing the automated information flow between PMIS could require manual transfer of information between systems, which is not a value-adding process. Therefore, finding a balance between automation and manual processes is crucial to optimize project efficiency and quality.

"Given the distinctive nature of the projects we handle, I hold a firm conviction that relying on automated and synchronized processes is disadvantageous" - Project Manager

Additionally, it is worth noting that synchronization is not always beneficial and some users of the systems believe that an automated and synchronized process would cause more problems than it would solve (Subject J, K & M). Some argued that automation may not be a practical solution because certain systems may output data in a format that is incompatible with the input of another system, necessitating at least a redefinition of the data set to enable synchronization (Subject E, H & L).

4.2.4 Complexity

The presence of multiple PMIS can lead to increased complexity within a company due to the uniqueness of the systems and the various ways in which users interact with them. Examining these complexities can provide valuable insights into the effect of multiple PMIS.

"The need to operate multiple systems, each demanding a distinct approach, contributes to the cumulative knowledge one must acquire" - Project Manager

Observations indicate that utilizing multiple PMIS increases the level of competence and knowledge required for operation. In order to effectively use more systems, the user must possess adequate knowledge within each system, which adds up when applying work across multiple systems (Subject G, H & I). However, using more systems may reduce the complexity of each individual system since their required functionality would be less than that of a single system (Subject J, L & M). In general, it is perceived to be easier to use fewer systems, as it enables the user to gain more experience in a specific system, resulting in reduced perceived complexities (Subject G, H, I & J). On the other hand, utilizing fewer systems prolongs the time required to learn the system to an adequate level of use, as the systems would have to be more complex to encompass the level of functionality that multiple systems would provide (Subjects L, M & O). When using multiple systems, which may be less complex, companies can onboard new staff more easily and require less time and effort from users to effectively use them (Subject N, P & Q).

"I prefer working with a limited number of systems as it enables me to specialize and enhance my efficiency within those systems, even if it entails dealing with increased complexity" - Project Manager

As an effect of increased perceived complexity of systems, users tend to find shortcuts in their way of working to achieve desired outcomes with minimal effort (Subject G, K, L & M). For instance, some users perform tasks outside of the main systems and later input their work into the system (Subject G, H, I & J). However, observations and interviews reveal that this approach may not be an effective solution to overcome the complexities of multiple PMIS used by the company. Conducting external work and inputting it into the main systems

can lead to inefficiencies as it requires double work, neglects the potential of the main system, and results in redundancies and increased costs (Subject P, Q & R).

"The complexity of certain systems often leads me to perform tasks outside of the system itself. For instance, despite having a project planning feature within the system, I find it more efficient to create the project plan in Excel and then import it into the system" - Project Manager

Furthermore, several interviewees state that using multiple systems for communication, data retrieval, and data processing can lead to challenges related to data integration and management, which can impact the projects as a whole (Subject I, K & L). Additionally, taking liberties of using systems outside of the main systems to overcome their complexities can increase the risk of errors. This is because it becomes harder to monitor, synchronize, and verify the information (Subject G, H & J).

4.2.5 Compatibility

When companies intend to use multiple PMIS, a significant challenge is ensuring that the systems are compatible with each other and capable of transferring, processing, and storing data in various formats. Analyzing compatibility challenges is crucial in the context of multiple PMIS, as it can have serious consequences if the systems are incompatible, and users are forced to treat each system separately.

"The lack of system integration and scattered information pose fundamental challenges for optimizing interactions between systems. Inconsistencies in data and the replication of information further exacerbate the problem, making it difficult to establish a single source of truth" - Head of Department

Regarding compatibility, there are opportunities to optimize interactions between systems, but Company X has observed some fundamental challenges. Firstly, having information scattered across multiple systems makes cooperation and information processing between systems increasingly difficult, which is often the result of a lack of integration of systems (Subject F, H & K). This lack of integration leads to inconsistencies in data between different systems, which is due to a lack of source data (Subject G, I & J). When there is no single

truth of source due to the presence of multiple systems, users tend to replicate data, further exacerbating the problem of information scattering and duplication within the systems (Subject G, H, I, J, K & L). In addition, compatibility issues between systems can make it challenging to backtrack information when working on projects that span over a long duration, which may be necessary during post-production stages such as maintenance and servitization (Subject K, M, P & Q). This challenge is compounded by the issue of information scattering, as traceability is lost between the systems, and finding the source of the information is nearly impossible without compatibility between the systems (Subject I, J & M).

"Compatibility issues between systems not only hinder information traceability but also complicate post-production stages like maintenance and servitization. Without effective integration and compatibility, backtracking information becomes a daunting task, impeding project progress and efficiency" - Head of Department

4.2.6 Risk for errors

It is crucial to understand the potential risks and errors that may arise when using multiple PMIS, as several dimensions related to the systems themselves can increase the likelihood of such errors if the systems are not optimized. These consequences can be serious and should be taken into consideration as a challenge to utilize multiple PMIS effectively.

"Using multiple systems carries a higher cumulative risk of malfunction due to system integration and dependencies. If one system fails, it can create a cascading effect that impacts the performance of the entire fleet of systems" - Technical Analyst

There is an assumption that using multiple systems carries a higher cumulative risk of malfunction than using fewer systems (Subject A, D & E), which is based on the notion that system integration and dependencies between systems can create a cascading effect if any one system malfunctions, ultimately affecting the performance of the entire fleet of systems (Subject B, C & F). Additionally, maintenance and updates to a single system can cause downtime and affect the connected systems due to dependencies (Subject B, C, D & E). To minimize downtime, Company X may sacrifice optimal bug testing and may miss errors and malfunctions within the systems (Subject D, E, N & Q), which can lead to delays in projects,

and subsequently cause a spiraling effect in resource usage and planning (Subject P, S, T & U). Subject O suggests that minimizing downtimes is critical to avoid delays at every step of the project process. Implementing new systems or integrating existing systems into the fleet can further magnify issues of implementation, integration, and have a causal effect on errors and downtime (Subject D, I & R).

"In the pursuit of minimizing downtime, we often face a trade-off between optimal bug testing and operational continuity. By sacrificing comprehensive testing, there is a risk of overlooking errors and malfunctions, leading to project delays and resource inefficiencies" - Head of Department

4.2.7 Summary: Systems

Considering the aforementioned factors that directly affect a company when utilizing multiple PMIS, it can be concluded from this theme that the interplay between these systems is far from simple. Table 4.2 presents an overview of the findings within the Systems theme.

Table 4.2: Summary table of Systems theme.

Code	Finding
Utilizing Multiple PMIS	- Can provide increased efficiency due to added functional capability and capacity of which information can be processed
	- Yields a decrease in traceability and reliability due to information scattering and duplication
	- No single truth of source
	- Flexibility in terms of adapting to project requirements
	- PMIS are rarely used to their full potential
System implementation	- Implementation of PMIS is paramount to functional performance, requires alignment of intent for use
	- Shifts heavy work-load to IT and may not always be successful
Synchronization	- Enhances dissemination of information
	- Automation is far more difficult to maintain, develop and monitor

	- Manual synchronization rarely creates value but enhances the vigilance of users
Complexity	- Increased complexity stems from additive complexity of separate PMIS along with higher competence requirements on users and developers - Users might take shortcuts to cope with complexities which makes it more difficult to monitor, synchronize and verify information - Complexities can cause redundant and inefficient work as well as managerial challenges and issues related to data integration
Compatibility	- Information scattering makes cooperation and processing between PMIS very difficult and often leads to lack of integration between systems - Lack of integration causes inconsistencies in data - When compatibility is insufficient, backtracking information can be near impossible, especially when working on long projects. This is problematic for projects during post-product stages such as maintenance and servitization
Risk of errors	- Cumulative risk of error is higher in multiple PMIS - PMIS require maintenance, updates and are susceptible to malfunctions. Connected systems are at risk of cascading effects which could lead to an increase in overall downtime - Downtime of PMIS can lead to delays in projects as each stage could be upheld by a previous stage if errors occur

4.3 Users

This section will discuss the findings from the Users theme. When analyzing the users theme the focal points were to study how users perceive, adopt, work, educate and fail when using multiple PMIS in an organization. In order to understand the overall effects of utilizing multiple PMIS, a crucial point of view is that of the users which constitute the work done within the systems.

4.3.1 User perception

User perception is important as it can reveal how users feel about the systems, their level of satisfaction with them, and how they perceive their impact on their work. Therefore, studying user perception of using multiple PMIS is crucial to answering the research question as it is a dimension of the effects PMIS can have on an organization.

"The use of multiple systems has had a negative impact on the overall user experience, as reported by most users. Navigating and using multiple systems increases their workload and frustration, leading to a loss of focus on their actual work" - Head of Department

Based on observations and interviews, most users of multiple PMIS reported negative effects on their overall experience using the systems (Subject G, H, I, J, K, L, O & P). Using multiple systems can lead to frustration among users as they have to learn to navigate and use multiple systems, which increases their workload (Subject G, I, K & L). This problem is compounded as users find it challenging to constantly adapt to new ways of working when they are introduced to new systems or switch between systems (Subject G, H, J & K). Users feel overworked and lose focus on the purpose of their work due to this constant adaptation (Subject H, K, L & M). Using multiple systems can also lead to a loss of trust in information, as information can differ between the systems they use, slowing down their work as they validate and verify information (Subject G, H, I & J). To overcome these issues, users tend to duplicate information when they are unsure about the quality of the observed information in a specific system (Subject G, H, J & L).

"The constant adaptation to new systems or switching between systems further exacerbates the challenges faced by users, causing fatigue and a lack of trust in the information provided. Users often feel the need to duplicate information as a precautionary measure" - Project Manager

Moreover, users reported feeling fatigued by constantly being introduced to new systems, and felt that little consideration was given to the benefits of using multiple systems in relation to the time and money required to utilize them (Subject G, H I, J, K & L). Additionally, users often faced uncertainty about the ownership of the systems they used, as they were sometimes used in departments that were not responsible for their maintenance (Subject I, J,

K & L). This uncertainty was compounded by the fact that the departments responsible for the systems did not prioritize functionality based on the needs of users, but rather on the department's control of the system (Subject G, H, J, M & P).

4.3.2 User adoption

It is crucial to comprehend the user adoption of multiple PMIS to gain insight into their experience while actively working and interacting within the systems. By recognizing the difficulties users encounter when using these systems, we can contribute knowledge to the overall impact of utilizing multiple PMIS.

"Infrequent usage of individual systems hinders me from becoming an expert, leading to heavy reliance on co-workers, IT support, and managers for assistance" - Project Manager

In the previous section, it was discussed how users tend to have a negative overall experience while using multiple PMIS. This section will further explore specific situations that occur within this context. Several interviews revealed that new employees find it challenging to locate information across multiple systems when they adopt a particular system's way of working (Subject G, H, I, J, K & L). Furthermore, users revealed that they often fail to become experts within specific systems due to infrequent usage of individual systems (Subject G, H, I & K). As a result, when problems arise, infrequent users tend to rely heavily on their co-workers, IT support, and managers for assistance (Subject D, G, J, N & P). Even after attending training to improve their system experience, users report losing knowledge gained due to infrequent usage (Subject H, I, K, Q & R).

"When a user only utilizes a certain system a few times per year, it becomes challenging to sustain competencies, even with education, since people tend to forget what they have learned during their training" - Project Manager

Infrequent use of a system has a direct correlation to perceived complexity, which can lead users to avoid using the system altogether or avoiding doing the work within the system (Subject I, J, K & L). Although users completely avoiding their work within a system is rare, it was observed that using alternative systems to conduct the same work and then disseminating that work to the main system can result in scattered information with low

quality. Moreover, using multiple PMIS is an inefficient use of resources as infrequent usage leads to less experience within each system, causing users to work at a slower pace (Subject G, H, O & P). Subject R highlighted that in Company X, users must choose between being an expert in a small area of a specific system or being knowledgeable across all systems. However, this becomes problematic because Company X expects users to be experts in several systems to conduct their work and produce the desired outcome, which is impossible in the current setting (Subject R).

"Users in Company X face the dilemma of either specializing in a small area of a specific system or having broad knowledge across all systems. This expectation poses challenges as it is impossible to achieve expertise in multiple systems within the current setting" - Head of Department

Finally, it is worth noting that when using multiple systems, they tend to be business-adapted, which means that the systems are tailored to align with the objectives of a specific department (Subject N, O & U). Consequently, new users of these systems find it challenging to navigate them if they do not meet their expectations or do not provide the functionality they require (Subject J, K & L). Moreover, using multiple systems puts pressure on users to maintain credentials and routines within each system, which has been expressed as a genuine concern that causes delays in work (Subject G, H, J, K & L).

"The use of multiple business-adapted systems tailored to specific departments creates difficulties for new users who struggle to navigate systems that may not meet their expectations or lack required functionality. The pressure to maintain credentials and routines in each system contributes to delays in work" - Head of Department

4.3.3 Way of working

The code in this context pertains to the user's approach to working with PMIS. Having an understanding of users' routines and guidelines for interacting and working with these systems is crucial to gaining insights into why certain effects may arise from a user perspective when using multiple PMIS.

"I often deviate from established guidelines when working with multiple systems, as each system has its own unique way of working. Even though this lack of adherence can lead to inconsistencies and inefficiencies in my workflow" - Project Manager

Interviews with users have revealed effects of two significant tendencies in how they work with PMIS. Firstly, users tend to deviate from established guidelines when they have to use multiple systems since each system has its own unique way of working (Subject G, H, I & K). This lack of adherence to guidelines can result in inconsistencies and inefficiencies (Subject N, O & P). As users are required to work with multiple PMIS, they must adapt to each system's unique way of working, which can be challenging when they have to switch systems frequently since workflows differ between systems (Subject G, H, J & L). Even if a user is familiar with one system, they may not be familiar with the workflow of another system, despite having the same function or purpose (Subject I, J & K).

"The need to adapt to different systems' workflows poses a challenge for us, particularly when we frequently switch between systems. Even if we are familiar with one system, we may struggle with the workflow of another system, despite having a similar function" - Project Manager

The second critical tendency among users is that they tend to rely on their colleagues for assistance when they encounter difficulties in retrieving information from systems they are not familiar with, instead of pursuing education (Subject J, K & L). Seeking guidance from more experienced colleagues enables users to receive hands-on help instead of attempting to apply educational materials to complex systems that may not cover all aspects (Subject C, F, G & H). Although this approach may appear reasonable, it has been noted that it results in several problems due to the absence of specific system guidelines (Subject G, J, N & Q). When multiple users use a system differently, it can also create inconsistencies in information, exacerbating the issue (Subject B, H, N & O).

"I tend to rely on my colleagues for assistance when encountering difficulties with unfamiliar systems, rather than seeking formal education" - Project Manager

4.3.4 Education

This section discusses the resources available for learning and utilizing PMIS within Company X. Examining the available resources, such as educational programs and system experts, is crucial in understanding the effects of using multiple PMIS from the perspective of system users. By evaluating the resources available, organizations can identify ways to address challenges and ensure that employees can work with the systems efficiently. This information is essential in answering the research question and gaining a causal understanding of the impacts of using multiple PMIS.

"Education on systems within Company X is pursued on a voluntary basis, with no mandatory requirements for employees when introduced to new systems" - Head of Department

The interviews conducted have uncovered some significant findings about the effects on education related to the presence of multiple PMIS. A significant challenge regarding education is that the way of working should be established before education is developed (Subject N, O, P & R). Unfortunately, this is not always feasible since users must start working with the system before the way of working is established (Subject H, N, O & Q). Moreover, hiring external educators is not an option since the way of working within the system, which is specific to the organization, is equally important as the system itself (Subject P, Q, S & T).

"Establishing the way of working before developing education programs presents a challenge, as we often need to start working with the system before the optimal workflows are determined" - Head of Department

An effect of utilizing multiple PMIS is that the educations tend to become more generalized due to the large size and diverse nature of the systems, which often leads to users only learning about the more straightforward aspects of the PMIS (Subject S, T & U). Consequently, users typically rely on their colleagues to gain the knowledge necessary to operate the system, which may not always align with the objectives for using the PMIS (Subject G, N, O & R). Additionally, even skilled educators may not be familiar with the unique working practices of various departments, and finding time to educate users can be

challenging as it requires educators to divert resources from active projects (Subject B, C, F, N, & P).

"The organization's size and diversity often result in generalized education about the systems, focusing on the more straightforward aspects. Employees then rely on their colleagues for knowledge acquisition, which may not align with the system's objectives" - Head of Department

4.3.5 Summary: Users

Considering the aforementioned factors that impact a company's utilization of multiple PMIS, particularly from the perspective of users handling the information within these systems, it can be concluded that users often experience confusion and frustration with having to operate multiple systems, lacking sufficient knowledge to solve problems on their own. As a result, they rely on tacit knowledge from colleagues to learn how to navigate these systems, as formal educational measures are often deemed inadequate. The perceived and actual effects from the user perspective can lead to inefficiencies, errors, and delays, as knowledge gaps arise and users struggle to become experts in all systems despite being expected to do so at times. Table 4.3 provides an overview of the findings related to the Users theme.

Table 4.3: Summary table of Users theme.

Code	Finding
User perception	- Users perceive multiple PMIS as having an overall negative impact on the user experience and demands put on users
	- When having to switch between PMIS, users perceive that it is impossible to gain enough experience to master all systems
	- Multiple PMIS causes a perception of inefficient work and users lose trust in information that is processed, which causes users to duplicate information
User adoption	- Users rarely become experts within PMIS due to infrequent use and must often choose a generalist approach across multiple systems despite being expected to be experts in several systems
	- Infrequent use inhibits problem-solving skills of users and users must resort to colleagues and IT-support for help
	- Educations are rarely fruitful as the lessons learned are infrequently applied and thus forgotten

	- Users neglect work as they are unable to conduct it on their own due to perceived complexity and inexperience
Way of working	- Users tend to deviate from established guidelines when they have to use multiple PMIS since each system has its own unique way of working - It takes considerable time for users to adapt to the unique workflows of PMIS, which causes inefficiencies and inconsistencies - Users resort to asking colleagues for help as educational state is not deemed to be helpful enough to resolve the complications
Education	- Education is only pursued when users consider it necessary, and there are no mandatory education requirements for users when they are introduced to new PMIS - Way of working needs to be established before education is developed. Unfortunately, this is not always feasible since users must start working with the PMIS before the way of working is established - External educators for PMIS are rarely useful as the educators need to be knowledgeable within the way of working, which is specific to the organization - PMIS education is often generalized and rarely target the prevalent issues that occur when using multiple PMIS - Finding time for PMIS education is difficult as it requires educators to pull active resources from their work

4.4 Governance

This section will discuss the findings from the governance theme. When analyzing the governance theme the focal points were to study the impact of the multiple PMIS on the company's internal politics, confidentiality of the information flow, and cost and maintenance. By analyzing the empirics from an governance perspective, insight will be given into how the organization is affected by the presence of multiple PMIS, but also why these effects might occur.

4.4.1 Cost & Maintenance

When organizations use multiple PMIS, it is important for them to take into account the costs and maintenance of these systems. This is a complex topic that can provide valuable insights into the effects the PMIS can have on governance and their effect on the organizational priorities.

"The cost of system licenses escalates with the number of systems used, posing a significant financial burden on the organization. This highlights the need for careful evaluation of the benefits and costs associated with utilizing multiple systems" - Head of Organization

The interviews conducted revealed several important insights into the effects of the cost and maintenance of PMIS within the organization. One significant finding is that the cost of system licenses increases with the number of systems used, making it an expensive endeavor for the organization (Subject N, O, S & T). As a result, maintaining multiple systems requires more system experts, effectively setting a higher demand for cost and maintenance on the organization (Subject N, Q, R & U). Moreover, compared to a single system, it is more difficult and resource-intensive to ensure the optimal functioning of multiple systems, requiring explicit responsibility, monitoring, and resources (Subject D, P, Q & T). As multiple PMIS require more cost and maintenance, documents and observations reveal that lacking a structured approach to evaluate the effectiveness of using multiple systems can potentially lead to inefficient use of resources or redundancies. An evaluation needs to be conducted to determine whether the use of multiple PMIS is beneficial in terms of time and money.

"Maintenance of multiple systems demands more system experts, increasing the demand for resources and adding to the organization's cost and maintenance requirements. A structured approach is necessary to assess the effectiveness and efficiency of using multiple systems" - Head of Organization

The education of users on multiple PMIS necessitates more resources, leading to increased costs, potential delays and problems due to the added complexity from a user's perspective (Subject N, O, P & Q). Furthermore, administrative costs are required for access control within the systems, which also increases with more systems (Subject N, O, P & R). Multiple PMIS can result in additional downtime for updates, malfunctions, and bug-testing, resulting

in significant cost increases (Subject A, D, E & P). According to Subject S, past observations indicate that downtime can be as high as 20% of the time spent working in PMIS for projects. This downtime represents unproductive time spent waiting for updates to complete, which can significantly increase project costs and impact efficiency.

"The presence of multiple systems introduces the risk of downtime for updates, malfunctions, and bug testing, resulting in increased costs and decreased efficiency. Unproductive time spent waiting for updates can significantly impact project costs" - Technical Analyst

4.4.2 Internal politics

In the context of using multiple PMIS, the internal politics and priorities of an organization have a significant impact on how these systems are utilized. Therefore, it is crucial to examine their role in order to understand the potential effects multiple PMIS has on them.

"Internal politics and budget competition among departments might hinder information sharing and project progress within the organization. Multiple systems exacerbate this issue by allowing for obscurity and personal agendas" - Head of Department

The interviews yielded valuable insights into the effects of internal politics and priorities of the organization, particularly regarding the use of multiple PMIS. One key finding was that lack of transparency in an organization may lead to personal agendas and multiple PMIS exacerbate the problem by allowing for obscurity (Subject N, O & Q). Since departments may compete for budgets, using multiple PMIS can allow and incentivize them to withhold information from other departments and delay projects (Subject N, O, P & R). Nonetheless, Company X generally emphasizes transparency to facilitate effective information flow between systems and departments (Subject N, R, S & T). However, it was noted that transparency between PMIS can also lead to issues within project management as incomplete documents might be used by other departments without knowledge of their unfinished status (Subject H, P, Q & R).

"Transparency is emphasized in Company X to facilitate effective information flow, but it can also lead to challenges in project management when incomplete documents are shared without knowledge of their unfinished status" - Head of Department

4.4.3 Confidentiality

Considering the potential impact on information confidentiality, the use of multiple PMIS raises critical concerns for organizations, especially when confidential information is involved in projects. As a result, the code governing the use of PMIS takes into account the effects of system utilization on information confidentiality. This understanding is crucial in answering the research question, as the inappropriate use of PMIS could have detrimental effects on projects.

"Confidentiality concerns arise with the use of multiple systems as not all information can be stored in every system due to classification restrictions. Ensuring system compatibility becomes crucial to efficiently manage and protect sensitive data" - Head of Department

Insights obtained from in-depth interviews with organizational representatives shed light on the confidentiality concerns related to the effects of the utilization of multiple PMIS. One key finding is that due to classification restrictions, not all information can be stored in all PMIS, which necessitates careful consideration of system compatibility to ensure efficient use (Subject A, D, P, S & R). Moreover, the use of multiple PMIS complicates confidentiality issues, as the likelihood of information leakage to unintended parties increases when multiple systems are interconnected, especially when dealing with customers, which could result in severe consequences in terms of unauthorized sharing of intellectual property (Subject N, O, T & P).

"The interconnected nature of multiple systems introduces complexities in maintaining confidentiality. The risk of information leakage to unintended parties, particularly when dealing with customers, increases, which can have severe consequences" - Head of Department

4.4.4 Summary: Governance

Considering the aforementioned factors that indirectly affect a company when utilizing multiple PMIS in terms of the organization that governs the systems, it can be concluded from this theme that the organization can be impacted by the presence of multiple PMIS. Table 4.4 presents an overview of the findings within the Governance theme.

Table 4.4: Summary table of Governance theme.

Code	Finding
Cost & Maintenance	- Cost and maintenance requirements increases with number of PMIS due to licensing, education and administration
	- More resource-intensive to ensure optimal functioning of PMIS
	- Educational requirements are increased and demand resources
	- Downtime due to updates, malfunctions and bug-testing can be as high as 20% when working in PMIS
Internal politics	- Multiple PMIS might enable incentivized information sharing when competing for budgets and priorities, promoting personal agendas
	- Transparency is recommended. Multiple PMIS can cause issues with departments utilizing unfinished and unrevised information
Confidentiality	- Multiple PMIS can cause issues with information sharing due to confidentiality of intellectual property
	- Confidential information can not be stored in all systems and thus compatibility between systems could be compromised

5. Discussion and recommendations

The following chapter will involve a discussion based on the results and analyzed data presented in the previous section. Its purpose is to connect the empirical evidence with the relevant methodology and literature, while also providing conclusions and recommendations for practice with regard to the research question of the report.

5.1 Summary of Findings

The study aimed to explore the effects caused by the presence of multiple PMIS empirically in an organization by answering the research question:

How does the use of multiple PMIS affect organizations?

The foundation of the study is built upon the existing gap in the literature where previous research does not explicitly consider the presence of multiple PMIS. Previous research studies PMIS within the confinement of a generalized or single application (Raymond & Bergeron, 2008; Ahlemann, 2009, Kaiser & Ahlemann, 2010; Winter et al., 2006). However, the research findings reveal that using multiple PMIS comes with complexities, challenges and opportunities that organizations, such as Company X, must acknowledge if they intend on using multiple PMIS.

The empirics of which constitute the main findings have been summarized and presented in Tables 4.1, 4.2, 4.3 and 4.4. By studying the effects of the presence of multiple PMIS, six main categories of findings were deduced to answer the research question:

- Complexity
- Synchronization
- Functional Capability
- Information Scattering
- User Experience
- Politics & Confidentiality

The data analysis revealed that these six categories were the most consequential and impactful to an organization when utilizing multiple PMIS. Therefore, it is important to analyze and discuss them further in order to gain an in-depth understanding of the effects caused by the presence of multiple PMIS.

5.2 Effects of multiple PMIS

Considering the existing gap in previous research and the effects of the presence of multiple PMIS, it can be concluded that a structured approach is needed to evaluate whether the use of multiple PMIS is beneficial considering the effects it might have.

5.2.1 Complexity

While complexity might refer to many things while studying organizations and their usage of information systems, the study categorizes complexities as the intricacies and nuances that have a causal effect due to the presence of multiple PMIS. It contains both aspects of complexities within systems as a direct result of having several systems reliant and interactive with each other, but also to the aspects relating to organizations and users that might adopt multiple PMIS in their operations. While the gathered empirics on complexities might be fairly scattered, it is important to analyze the relationship between these complexities to comprehend how they may inhibit users and systems from being as efficient and functional as possible. Within the unit of analysis, it is of interest to understand why the complexities arise and how they affect the surroundings, which ultimately serves as a foundation for practical implications of what can be done to mitigate them.

Starting with the first aspect, using multiple PMIS can increase the complexity of systems in an additive manner. While previous research show that project managers appear more inclined to adopt PMIS when they are free of complexities (Caniëls & Bakens, 2012; Raymond & Bergeron, 2008), empirics show that each system has its own distinct role, and it needs to be compatible and integratable with other systems, thus setting higher demands on the competencies of users and developers. Additionally, while previous research rarely considers the increasing complexity of PMIS (Ahlemann, 2009), the empirics show that PMIS are not used to their full potential due to complexity, which can cause redundancies, malfunctions, and delays, emphasizing the importance of addressing system complexities. However, if managed properly, increasing the complexity within systems can also enhance the overall capacity and potential of tasks that can be carried out, and it can reduce the need for multiple PMIS.

Moving on to the second aspect, the complexity experienced by users and the organization is strongly correlated with the perceptions of the users. As complexity increases, users may

perceive that the functionality of the systems surpasses their current competence. As discussed by Caniëls & Bakens (2012), when project workers are exposed to complexities, it leads to confusion on how and why they should perform their tasks. While this complexity refers to project complexity, a similar take can be made on system complexity as the systems are operated in order to conduct the projects, thus causally increasing complexity of the project. Consequently, the empirics of the case show that perceived complexities among users can lead to inefficiencies without proper support and alignment from the organizational side, and users may neglect the systems altogether. It was found that it is important to establish a coherent way of addressing these issues where the users and organizations' interests align. Research has shown that users might become reluctant to adopt systems based on their perception of the system, which often is related to how well the systems support their work (Saeed & Abdinnour-Helm, 2008). Similarly, the empirics show that when users perceive themselves to be unable to solve problems due to complexity-related issues, it can have a spiraling effect on the organization, as users might become reluctant to use the systems altogether.

In conclusion, it is essential to understand the relationship between the complexities that arise from using multiple PMIS to comprehend how they may inhibit users and systems from being as efficient and functional as possible.

5.2.2 Synchronization

The concept of synchronization is essential in the management of information flow between multiple PMIS in an empirical setting. The term, however, lacks a clear definition and can be ambiguously interpreted. Nonetheless, synchronization can be broadly understood as the processing and updating of information that flows between systems, which can be achieved either manually or automatically. While it can occur in varying degrees of automation, ranging from fully manual to fully automatic, it is essential to analyze the options to gain insights into the effects that it may cause as a result of using multiple PMIS. Empirical evidence suggests that synchronization of information is necessary for the dissemination of data between systems and ensures the quality and accuracy of information. By comparing and analyzing manual versus automated synchronization, insights can be gained into the potential complexities, challenges, and opportunities that each method presents, leading to recommendations for best practices in this area.

Automated synchronization of information has significant implications for organizations, as it can effectivize and enhance the quality of information and increase the possibility of tracing data back to its source, reducing input errors and improving data reliability. A core goal of adopting PMIS is that it enables tasks and information to be timely updated (Braglia & Frosolini, 2014), which is further emphasized when utilizing several systems that need to cooperate. Since scholars have not explicitly examined the use of multiple PMIS, synchronization between the systems is a topic of which there is limited research. However, most researchers in the field of PMIS agree that information within the PMIS needs to be held to a certain level of quality, reliability and accessibility for users (Raymond & Bergeron, 2008; Caniëls & Bakens, 2012). The empirics show that automated synchronization aids in this manner by ensuring that updates are propagated simultaneously across all connected systems, preventing data from being scattered and ensuring consistency across the organization.

However, automated synchronization adds complexity to IT infrastructure, making it more difficult to develop, monitor, and maintain from an IT perspective. IT-related downtime due to updates, malfunctions, and bug-testing can significantly affect the entire connected fleet, potentially leading to significant downtime and associated costs. One major challenge with automated synchronization is that it requires careful configuration and maintenance, which can be increasingly difficult with each system added to the automation. Moreover, the automation needs to be adaptable to the objectives of each department and the projects being conducted. Thus, configuring the automation to the specific needs of each department can be challenging and potentially result in further downtime if changes to the automation need to be made while in use.

Despite the challenges associated with automated synchronization, its potential value in effectivizing workflows in an organization is evident. Manual synchronization between systems is essentially duplicating work and does not add value to the organization.

5.2.3 Functional Capability

One of the key findings is the direct correlation between the presence of multiple PMIS and functional capability within an organization. This relates specifically to the dimensions of

organizational use, functional enhancements, and user adoption to comprehend the effects that occur when these systems are used and their implications for the organization.

From a systems perspective, empirical evidence suggests that utilizing multiple PMIS can add functional capability by processing more information, increasing processing speed, and enhancing computing power within the organization. It demonstrates that the flexibility of these systems is also increased, enabling organizations to adapt to specific project requirements. Comparatively to the research on PMIS, the empirics suggest a much similar finding to that of a generalized single-use of PMIS. Scholars demonstrate that PMIS is of great importance to enhancing project outcomes (Raymond & Bergeron, 2008; Ahlemann, 2009, Kaiser & Ahlemann, 2010; Winter et al., 2006), by optimizing existing project management processes through usage of PMIS. However, when using multiple PMIS key takeaways relating to processing power and speed are further enhanced compared to a situation where the alternative is not using PMIS at all. Despite the highlighted improvements that multiple PMIS might enhance, it is also of importance to look at the challenges that arise by using multiple PMIS.

While the added degree of flexibility can be advantageous, it can also be demanding on users and the organization. Users may find it overwhelming to utilize several systems to accomplish an objective as they lose track of the big picture, causing uncertainties in the way of working and the purpose of their work. Similarly, as demonstrated by Caniëls & Bakens (2012), a situation where users are forced into using a single application of PMIS that is perceived to be too complicated. Additionally, a high degree of system flexibility can lead to issues with mastery within the systems as each project requires learning how to use the systems uniquely.

From an organizational perspective, utilizing multiple PMIS requires more resources to ensure alignment with project objectives and to coordinate the effort effectively. This added demand can be more resource-intensive than single PMIS usage. However, when fully and functionally integrated, utilizing multiple PMIS can enhance computing power, handle larger data sets during projects, increase user efficiency, and ultimately make decision-making and output-gathering more effective.

5.2.4 Information Scattering

The information flowing in the PMIS has been confirmed to be a central aspect of the research and remains as one of the key findings in relation to the effects of the presence of multiple PMIS. This relates specifically to the fact that multiple PMIS equates to information being stored and processed in multiple systems simultaneously and risks becoming scattered.

The presence of multiple PMIS poses several challenges for organizations, as information is stored and processed across various systems. One of the key challenges is the potential loss of a single truth of source, which can have cascading effects on the accuracy and reliability of information. Previous research shows that an arbitrary PMIS system needs to have precise and reliable information output to be considered of high quality (Raymond & Bergeron, 2008; Braglia & Frasolini, 2014). While the empirics show that a challenge of having multiple PMIS is that information becomes scattered and therefore the reliability of information is reduced, it can be deduced that multiple PMIS causally can have detrimental effects to an organization if managed without synchronized information. For instance if different systems store contradictory information, it can be challenging to determine which information is correct, leading to confusion and mistakes.

To illustrate, suppose that an organization's customer database is split across two different systems. One system contains information about customer orders and payments, while the other contains information about customer complaints and feedback. If the systems are not integrated and do not have a single truth of source, it can be difficult to determine which system has the most up-to-date information about the customer. This can lead to issues such as sending customers incorrect or outdated information or not addressing customer complaints adequately.

Additionally, in the context of the illustration, updating information when there is no single truth of source can reduce the quality of the information, especially if there is no integration or synchronization between the systems. This finding in the empirics is closely aligned with a scenario proposed by Caniëls & Bakens (2012), where user perceptions of untrustworthy information causes PMIS to lose its function. Translated to the case of multiple PMIS, as a consequence users may end up duplicating information in the systems due to lack of trust, exacerbating the issues with information scattering. Furthermore, the scattering of

information across multiple PMIS can make it challenging to gain an overview of the information in the systems, as compiling information from different systems is time-consuming and can lead to an inefficient use of resources.

It is important to note that addressing the challenges posed by information scattering requires the cooperation and processing of information between the PMIS. This means that the systems must be integrated and synchronized to ensure that they are working together to achieve the same goal, which can involve establishing data standards and protocols to ensure that information is consistent across systems.

5.2.5 User Experience

The user's experience of working with PMIS is another confirmed central aspect of the research and remains as one of the key findings in relation to the effects of the presence of multiple PMIS. This relates specifically to the fact that multiple PMIS equates to additive requirements from the user.

User perception and user acceptance of PMIS systems has been discussed by many scholars and there is a general consensus that users need to be satisfied with the PMIS in order for it to be efficient (DeLone & McLean, 2002; Caniëls & Bakens, 2012; Raymond & Bergeron, 2008; Lee & Yu, 2012; Saeed & Abdinnour-Helm, 2008). Aligned with previous research, the empirics found that the presence of multiple PMIS can have a significant negative impact on the use of PMIS through user experience, as it demands more effort from users to adapt to and work with multiple systems. The negative impact on the user experience is further compounded by the fact that working with several PMIS makes it almost impossible to gain enough experience to master all systems, which is exemplified by systems requiring a unique way of working. As a result, users rarely become experts within PMIS, and most often choose a generalist approach across the systems despite being expected to be experts in several systems.

This lack of expertise can lead to a perception of inefficient work, causing users to lose trust in the information that is processed, and leading them to duplicate information. Additionally, the presence of multiple systems causes infrequent use of some systems, which inhibits the problem-solving skills of users, making them resort to colleagues and IT-support for help.

This can create a dependency on others for assistance, leading to further inefficiencies and delays in getting work done.

Previous research emphasizes the need for education within PMIS systems (Pellerin et al., 2013). Despite the emphasis on need for education and demands of user satisfaction, the findings reveal that educations within multiple PMIS are rarely fruitful as they are very generalized, and when lessons learned are infrequently applied, due to infrequent use of a system, they are forgotten. As a result, users tend to deviate from established guidelines when they have to use multiple PMIS since each system has its unique way of working. This can create inconsistencies in how work is done, making it challenging to maintain a high level of quality and accuracy in the information.

Moreover, it takes considerable time for users to adapt to the unique workflows of PMIS, which also causes inefficiencies and inconsistencies, as the way of working needs to be established before education is developed. Unfortunately, this is not always feasible since users must start working with the PMIS before the way of working is established. Even if external educators for PMIS are available, they are rarely useful, as the educators need to be knowledgeable within the way of working, which is specific to the organization.

5.2.6 Politics & Confidentiality

The internal politics and confidentiality of information within the systems is considered to be influential to the research and remains as one of the key findings in relation to the effects of the presence of multiple PMIS.

The presence of multiple PMIS in an organization can have significant implications for its politics and confidentiality. Firstly, competition between departments for budgets can incentivise them to withhold information from each other, leading to delays in projects and potential conflicts between departments. This is because budgets are often allocated based on the amount of information handled, and sharing information may mean sharing the budget with the department it was shared with. This lack of transparency and trust can lead to personal agendas and multiple PMIS can exacerbate the problem by allowing for obscurity.

Furthermore, the presence of multiple PMIS can also cause issues with information sharing due to the confidentiality of intellectual property. Previous research shows that sharing information among project stakeholders is a major purpose of PMIS (Mishra & Mishra, 2013; Kaidalova et al., 2018; Mehta et al., 2016; Lee & Yu, 2012), and can negatively affect user experience by not doing so (Lee & Yu, 2012). However, the empirics show that confidential information cannot be shared and stored in all systems, and thus compatibility between systems could be compromised as well as user experience. This means that sensitive information may have to be manually transferred between systems, which can be a time-consuming and error-prone process. In addition, the risk of data breaches or unauthorized access to confidential information increases when information is shared between multiple systems.

Another challenge related to politics and confidentiality in the context of PMIS is the need for different levels of access to information. Even though Raymond & Bergeron (2008) show that the quality of a PMIS is linked to the accessibility of the systems and the information within, the empirics show that this could be problematic in scenarios of where information may be inaccessible or confidential. For example, some information may only be relevant to a select few individuals within an organization and should only be accessible to them and could thus complicate access to others who might want or need the information. The presence of multiple PMIS can make it difficult to manage access to information, potentially leading to the leakage of sensitive information.

5.3 Academic implications of multiple PMIS

This study contributes to the project management literature by shedding light on the presence of multiple PMIS within organizations and their impact on project management practices. The findings of this study highlight the need for project managers to consider the potential challenges and benefits of multiple PMIS when implementing and managing projects. The following implications for academic research emerge from the study:

First, the study contributes to the understanding of PMIS and reveals the need for further investigation into the impact of multiple PMIS on project management practices. While previous studies have focused on the effects of PMIS in a generalized or singular application (Raymond & Bergeron, 2008; Ahlemann, 2009, Kaiser & Ahlemann, 2010; Winter et al.,

2006), this study highlights the importance of understanding the implications of multiple systems and their interaction with each other. It is of particular importance due to the effects that may arise when multiple PMIS are present and should be studied empirically on a larger scale.

Second, the study emphasizes the importance of considering the broader organizational context in which multiple PMIS are implemented. Multiple PMIS are not implemented in isolation but rather are part of a larger organizational system. Therefore, understanding the organizational context is critical in understanding the potential benefits and challenges associated with the implementation of multiple PMIS. By excluding the organizational context, effects of multiple PMIS might be invalidated by phenomena that stem from organizational practices.

Third, the study underscores the need for research into the development of effective strategies for managing multiple PMIS in organizations. While multiple systems can offer benefits, they can also create challenges, such as data inconsistency and duplication. Developing effective strategies for managing multiple PMIS is crucial for ensuring their successful implementation and use. Failing to address the necessary research required for the management of multiple PMIS inhibits the use of the systems and effectively affects organizations. As organizations develop and grow increasingly complex, the research should develop to cope with these changes accordingly.

Overall, this study provides important insights into the presence of multiple PMIS in organizations and their impact on project management practices. The implications outlined above suggest avenues for future research that can contribute to a deeper understanding of PMIS in project management and inform the development of best practices for their implementation and management.

5.4 Practical implications of multiple PMIS

The utilization of multiple PMIS within organizations brings about various practical implications that must be addressed to ensure the efficient and effective operation of these systems. Failure to recognize and mitigate these implications can result in redundancies, malfunctions, delays, information scattering, and challenges in user adoption. This subchapter

explores the practical implications of multiple PMIS and offers recommendations for organizations to overcome these challenges.

5.4.1 Complexities within the Systems

Multiple PMIS introduce complexities that can hinder their full potential utilization. These complexities may arise from differences in system architecture, data structures, user interfaces, and functionality. Consequently, users may struggle to navigate and utilize the systems effectively, leading to inefficiencies and underutilization. To address these complexities, guidelines and technical competency of users and developers are necessary. Users should receive training and support to enhance their understanding and proficiency in operating the systems, while developers should strive for system compatibility and seamless integration to facilitate user adoption and utilization.

5.4.2 Resource Allocation and Benefit Assessment

Organizations must carefully weigh the potential benefits of utilizing multiple PMIS against the available resources. Evaluating the benefits should consider both the systems' capabilities and the organization's capacity to leverage them effectively. Adequate resources, including financial, technological, and human resources, should be allocated to ensure the smooth operation, integration, and maintenance of multiple PMIS. It is essential to assess the systems' potential impact on productivity, efficiency, and decision-making processes to make informed resource allocation decisions.

5.4.3 Support and Alignment from the Organization

Without proper support and alignment from the organizational side, multiple PMIS can result in inefficiencies and user neglect of the systems. The organization should provide adequate support and guidance to users to overcome the complexities inherent in utilizing multiple PMIS. This support can be in the form of training programs tailored to specific workflows and processes, establishing guidelines and best practices, and allocating resources for users to master the PMIS effectively. By doing so, the organization can increase user confidence and trust in the information processed, leading to improved user experiences and enhanced efficiency.

5.4.4 Synchronization and Compatibility

The presence of multiple PMIS introduces the challenge of synchronization and compatibility. Inadequate synchronization can result in data discrepancies, information scattering, and operational inefficiencies. Organizations must carefully evaluate the synchronization requirements and consider the potential benefits and challenges of automated synchronization. Manual synchronization or separate unconnected systems can be employed as alternatives to mitigate the cascading effect of potential malfunctions. Time-sensitive projects or organizations with limited IT resources may find manual synchronization or separate systems a safer option. However, if obstacles to automated synchronization are adequately addressed, it can provide significant value.

5.4.5 Information Management and Access Control

The utilization of multiple PMIS brings forth challenges in information management and access control. Organizations must establish clear policies and guidelines for the management of information within PMIS. It is crucial to ensure that confidential information is handled appropriately and that the systems are compatible with each other in terms of data exchange and security protocols. This requires a collaborative effort from all departments within the organization to establish transparent and secure information-sharing practices.

To address these challenges, organizations should invest in specialized training programs for employees. These programs should emphasize the importance of confidentiality and provide guidelines for handling sensitive information within PMIS. By ensuring that employees understand the significance of data security and adhere to established guidelines, organizations can minimize the risk of data breaches and information leaks.

5.4.6 Single Source of Truth

One of the key considerations when utilizing multiple PMIS is maintaining a single source of truth for information. Information scattering across various systems can lead to duplication, inconsistency, and confusion among users. To mitigate these risks, organizations should prioritize investing in a main system that holds all the information and ensures a single source of truth. This main system should serve as the central repository where data is stored, processed, and managed. By consolidating information into a single system, organizations

can improve the accuracy, reliability, and accessibility of project data, enabling better decision-making and reducing the risk of errors caused by inconsistent or outdated information.

5.4.7 User Experience and Workflow Consistency

Multiple PMIS can impact the user experience and introduce inefficiencies if users deviate from established workflows or struggle to navigate different systems. To mitigate the negative impact on user experience, organizations should prioritize investing in training programs tailored to the specific workflows and processes of their PMIS. By providing targeted training, users can gain the necessary skills and knowledge to effectively utilize the systems and maintain consistent workflows. Establishing guidelines and best practices that are consistent across systems also helps reduce inefficiencies caused by user deviations. Furthermore, organizations should ensure that users have adequate support and resources to master the PMIS, which can increase their confidence, trust, and productivity.

5.5 Limitations of the Study

While the findings of this study provide valuable insights into the effects of multiple PMIS on organizations, there are several limitations to consider. These limitations may impact the generalizability of the study and should be taken into account when interpreting the results.

One potential limitation of this study is the relatively small sample size. While efforts were made to ensure that the sample was diverse and representative, it is possible that the findings may not apply to all organizations or industries. Future studies with larger samples may provide a more comprehensive understanding of the effects of multiple PMIS, by for example examining and comparing the use of multiple PMIS within several companies.

Another limitation of this study is the use of self-report data. While efforts were made to ensure that participants were honest and accurate in their responses, it is possible that some participants may have over- or under-reported their experiences with multiple PMIS. Additionally, self-report data may be subject to response bias, where participants may provide socially desirable answers or may not accurately recall their experiences.

The study is also limited by its cross-sectional design, which only captures a snapshot of the effects of multiple PMIS at a particular point in time. In contrast to longitudinal studies that follow organizations over time and might provide a more nuanced understanding of the effects of multiple PMIS and how they change over time.

Furthermore, the study is limited by the scope of the research questions and data collection methods. While efforts were made to capture a wide range of experiences and perspectives, there may be other factors that were not considered or measured in this study that could influence the effects of multiple PMIS on organizations.

Finally, the study is limited by its focus on the effects of multiple PMIS on organizations in general, without focusing on specific PMIS or industries. While the findings provide valuable insights into the broad implications of multiple PMIS, they may not apply to organizations or industries with unique requirements or characteristics.

In terms of generalizability, it is important to note that the findings of this study may not apply to all organizations or industries. The sample was diverse and representative, but it is possible that the effects of multiple PMIS may vary based on organizational size, industry, or other factors. Additionally, the study only captures a snapshot of the effects of multiple PMIS at a particular point in time and may not reflect the long-term or cumulative effects of multiple PMIS. It is also important to consider the limitations of the study when interpreting the generalizability of the findings. Overall, while the findings of this study provide valuable insights into the effects of multiple PMIS on organizations, they should be interpreted with caution and may need to be confirmed through additional research.

5.6 Sustainability

Sustainability is an increasingly important consideration for organizations in all industries, including those that rely on PMIS. While the current study did not directly investigate the sustainability implications of PMIS, it is worth discussing how PMIS can impact sustainability in general.

PMIS can have both positive and negative impacts on sustainability. On the one hand, PMIS can help organizations reduce waste and improve efficiency by streamlining project

management processes. For example, PMIS can help reduce the amount of paper and physical resources required for project documentation and communication. Additionally, PMIS can help organizations monitor and optimize resource utilization, leading to reduced energy consumption and emissions.

On the other hand, PMIS can also contribute to sustainability challenges, particularly if they are not designed and implemented with sustainability in mind. For example, PMIS can require significant energy consumption and infrastructure, leading to increased carbon footprint. Additionally, the continuous upgrading and maintenance of PMIS can generate electronic waste, which can be harmful to the environment if not disposed of properly.

Another important consideration related to sustainability and PMIS is the impact of PMIS on the social sustainability of organizations. PMIS can lead to increased transparency and collaboration, which can help create a more inclusive and equitable work environment. However, PMIS can also create new challenges related to work-life balance and job security, particularly if PMIS are used to monitor and control employee performance.

To address these sustainability challenges, organizations can take a number of steps. First, organizations can prioritize the selection and implementation of PMIS that are designed with sustainability in mind. This can include PMIS that are cloud-based, require minimal infrastructure and energy consumption, and promote paperless project management processes. Second, organizations can invest in employee training and engagement to ensure that employees understand the sustainability implications of PMIS and are motivated to use PMIS in sustainable ways. Finally, organizations can establish sustainability goals and metrics for PMIS and regularly monitor and report on progress towards these goals.

In conclusion, while PMIS can have both positive and negative sustainability implications, organizations can take steps to ensure that PMIS are used in a way that promotes sustainability. By doing so, organizations can not only reduce their environmental impact but also create a more inclusive and equitable work environment that promotes social sustainability.

5.7 Recommendations for Future Research

Given the limitations of this study, there is room for further research to deepen the understanding of the role and impact of PMIS in project management. One area for future research is examining the role of PMIS in project success. Specifically, researchers could explore how PMIS can be used to support project governance, including enhancing transparency, accountability, and stakeholder engagement.

Another area of future research is studying the impact of emerging technologies on PMIS. As new technologies such as artificial intelligence, machine learning, and blockchain are increasingly being integrated into PMIS, it is important to investigate their impact on project governance and the challenges associated with their adoption and implementation.

In addition, investigating the impact of PMIS on organizational culture and behavior could be an interesting avenue for further research. PMIS can significantly impact organizational culture and behavior, particularly when it comes to information sharing, collaboration, and decision-making as human interactions are reduced and processes are increasingly shifted towards IT-based solutions. Future research could examine how PMIS can be used to support positive organizational culture and behavior.

Finally, this study focused on the use of PMIS in a specific organizational context. Future research could explore the use of PMIS in different project contexts, including different industries, project types, and project sizes. By exploring PMIS in different contexts, researchers could gain insights into the factors that influence the use and impact of PMIS in project management.

5.8 Recommendations for Practice

Based on the findings and limitations of this study, the following recommendations for practice are suggested:

1. Invest in PMIS training and development: To maximize the benefits of PMIS, organizations should invest in training and development for project managers and team members. This will help ensure that they have the necessary skills and knowledge to use PMIS effectively and efficiently.

2. Prioritize user experience and usability: PMIS should be designed with the user in mind, with a focus on usability and user experience. This can help increase adoption rates and ensure that the system is used effectively.
3. Implement change management strategies: The implementation of a PMIS can be a significant change for an organization. To minimize resistance and ensure a successful transition, change management strategies should be implemented. This can include stakeholder engagement, communication, and training.
4. Tailor PMIS to specific project needs: Not all projects are the same, and PMIS should be tailored to meet the specific needs of each project. This can include customization of the system and the integration of specific features and functionalities.
5. Regularly evaluate and update PMIS: PMIS should be regularly evaluated to ensure that it is meeting the needs of the organization and that it remains relevant and up-to-date. This can include the implementation of user feedback mechanisms and the evaluation of performance metrics.

By following these recommendations, organizations can improve the effectiveness and efficiency of their project management processes through the use of PMIS.

6. Conclusion

The study examined the presence of multiple PMIS in an organization and the complexities, challenges and opportunities associated with their use. While there is extensive research on the impact of PMIS on project outcome, the study focused on the effects of the presence of multiple PMIS in an organization. Through the analysis of qualitative data gathered from interviews, observations and document review, several key findings have emerged.

The findings suggest that the presence of multiple PMIS can have several effects on an organization. On one hand, the use of multiple PMIS can provide organizations with a range of tools to manage their projects and improve decision-making. On the other hand, it can lead to information scattering and complexities as well as affecting the user experience, politics and information confidentiality. Compatibility, integration and synchronization between systems was emphasized to be an overall enabler for efficient use of multiple PMIS.

Furthermore, this study discussed the implications of the findings for project management practices and recommended several strategies to address the identified challenges. Organizations should invest in PMIS training and development and prioritize user experience and usability. They should also implement change management strategies and tailor PMIS to specific project needs. Lastly, they should regularly evaluate and update PMIS.

Additionally, the study highlights several areas for future research. Future studies could explore the role of PMIS in project governance, the impact of emerging technologies on PMIS, and the use of PMIS in different project contexts. Moreover, research could investigate the impact of PMIS on organizational culture and behavior, particularly when it comes to information sharing, collaboration, and decision-making.

Conclusively, the findings of this study contribute to a better understanding of the complexities, challenges and opportunities associated with the presence of multiple PMIS in an organization. By adopting the recommendations provided in this study, organizations can maximize the benefits of PMIS and minimize the challenges associated with their use.

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