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APPLICATION INTEGRATION EXPERIENCES IN FINNISH SOFTWARE COMPANIES

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TIIVISTELMÄ

Lappeenrannan-Lahden teknillinen yliopisto LUT
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Tietotekniikan koulutusohjelma
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Sovellusintegraatiokokemuksia suomalaisissa ohjelmistoyrityksissä
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Sovellusintegraatiot mahdollistavat liiketoimintakriittisten järjestelmien toiminnan ja ne voivat luoda merkittävää lisäarvoa organisaatioille ja sidosryhmille. Useilla organisaatioilla on kuitenkin vaikeuksia saavuttaa asetetut integraatiotavoitteet, kun taas osa organisaatioista onnistuvat niissä paremmin. Diplomityö pyrkii tunnistamaan onnistuneiden integraatioiden menestystekijät ja mahdolliset ongelmat suomalaisten ohjelmistoyritysten näkökulmasta. Tutkimusaineisto koostuu 20:stä teemahaastattelusta, jotka suoritettiin SASSE tutkimusryhmän toimesta. Kerätty tutkimusaineisto analysoitiin temaattisen analyysin avulla. Tutkimusaineistosta tunnistettiin kuusi laajempaa teemaa liittyen integraatioiden menestystekijöihin ja viisi teemaa liittyen ongelmiin. Menestystekijöistä löydettiin lisäksi 20 alateemaa ja ongelmista löydettiin 16 alateemaa. Diplomityö tehtiin osana laajempaa SASSE tutkimusprojektia.

ABSTRACT

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Application integration experiences in Finnish software companies
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87 pages, 7 figures, 22 tables, 2 appendices
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Application integrations can enable business-critical processes and create significant value for organizations and different stakeholders. However, several organizations struggle to meet their integration objectives while others seem to implement them without significant problems. This thesis focuses to identify what are the integration success enablers and potential obstacles from the perspective of Finnish software companies. The research data consists of 20 semi-structured interviews conducted by the SASSE research team. The data was analysed following principles of thematic analysis. The analysis resulted in six success enabler themes and five obstacle themes. The themes were further divided into 20 sub-themes in enablers category and 16 sub-themes in obstacles category. The thesis research contributed to the first phase of larger SASSE research project.

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Jani Haimilahti

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LIST OF SYMBOLS AND ABBREVIATIONS

API	Application Programming Interface
COTS	Commercial of The Shelf
EAI	Enterprise Application Integration
EiPaaS	Enterprise Integration Platform as a Service
ERP	Enterprise Resource Planning
ESB	Enterprise Service Bus
FRENDS	Front-end Dialing Systems (EiPaaS offered by HiQ)
iPaaS	Integration Platform as a Service
KPI	Key Performance Indicator
SASSE	Strategic approach to scalable platform-based software and systems development
SOA	Service Oriented Architecture

1 INTRODUCTION

Most organizations rely on a heterogeneous set of software applications and systems to run their day-to-day operations. Many software applications are utilized across the entire organization to perform business-critical processes, and data is often transferred via networks between distributed computer systems. The demand for application and system integrations has existed for years and move towards more distributed systems has increased the need to consider integrations in every software development initiative. (Themistocleous, 2004)

It is not enough that integration development practitioners hold strong technical skills, but the cross-functional skills are essential too. There is a high demand for professionals who understand both internal and external business requirements, related applications and can integrate these disparate data sources and functions for the benefit of the organization. (Ragowsky et al., 2014)

A large multinational enterprise can hold hundreds, or even thousands of different software applications utilized in their daily operations and therefore integrating and managing this heterogeneous ecosystem is a demanding challenge. (Lam, 2005) The application ecosystems are often built over the years and ecosystems can include a wide array of legacy software applications and systems, applications developed in-house by IT department, modern cloud-based applications or native mobile applications. The software ecosystem stakeholders often expect that the applications can easily transfer data between applications, but this is seldom the case. Many software products are not originally designed to integrate with other applications or systems, and, e.g. data models can be different. (Freire et al., 2019). Integrations can offer significant benefits for organizations, but there are still considerable obstacles to meet planned objectives.

The master's thesis is focused on uncovering two perspectives of application integration initiatives according to Finnish software industry practitioners. The research aims to understand what the perceived success enablers and potential obstacles are.

1.1 Background & research objectives

The master's thesis is completed as a part of larger SASSE research project. The author is employed by SASSE project as a research assistant to contribute to the first phase of SASSE research within a limited scope. The SASSE is an abbreviation of Strategic Approach to Scalable Platform-Based Software and Systems Development. "SASSE project tackles the problem of utilizing and integrating to external software-based platforms and infrastructures. Our main objective is to create a theory that explains the success of how software and systems developing organizations can exploit external and often global platforms for creating scalable systems and services." (sasseproject.net, 2020)

The SASSE project consists of three distinct phases which are exploration, distillation and theory. The exploration phase focuses on studying how Finnish software companies utilize external platforms and what efficient and effective integration methods and processes are. The master's thesis scope is related to the SASSE project phase one. The distillation phase continues to observe Finnish technology companies, but the focus is more on seeking best practices and strategies for external platform integration. The third and final phase of the SASSE research aims to build a comprehensive theory and model of sustainable software platform exploitation. This final phase includes both software engineering and business perspectives. (SASSE research plan, 2019)

The master's thesis research objective is to gain knowledge about perceived factors contributing to implementation and development of application integrations from the perspective of Finnish software companies. The thesis research objective can be further divided into two related categories.

These categories are enablers of successful integrations and obstacles hindering the successful outcome. The research aims to understand what factors enable some companies to implement successful integrations while others are struggling or even abandon their development projects. The research objective is aligned with the SASSE research project.

1.2 Research questions

The research questions are general statements what the expected or planned knowledge gains during the research project are. The research can be considered to meet the set targets if the intended knowledge is discovered during the research. (Runeson, Höst, Rainer, & Regnel, 2012). This chapter introduces two research questions which were set to guide research. Research question 1 (RQ1) is related to the perspective of integration enablers, and the research question 2 (RQ2) consists of perspectives regarding potential integration obstacles.

> **RQ1:** *What are the enablers of successful application integration from the perspective of the selected Finnish software industry practitioners?*
>
> **RQ2:** *What are potential integration obstacles recognized by Finnish software industry practitioners?*

The thesis research aims to seek answers to these two main research questions by conducting several semi-structured research interviews during spring 2020 in the Finnish software industry companies. All research interviews are conducted in collaboration with the SASSE research team.

1.3 Thesis structure

The master's thesis paper consists of six distinctive parts. The first chapter introduces the research background and builds context to the remaining document. The chapter also presents selected research questions and what are the objectives of the thesis.

The second chapter includes a brief literature review regarding application integrations in general and what the identified enablers and obstacles are. The chapter ends with a short summary.

The third chapter includes an introduction to research methodology and rationale behind selected research methods in this research project. The chapter offers a detailed description of each research phase completed during the thesis.

The fourth chapter presents the research findings and analysis of the interviews conducted during the thesis project. The chapter also includes text extracts from the interview transcripts to illustrate research results and findings.

The fifth chapter offers a discussion about significant research findings and comparisons to previous research. The chapter also suggests potential future research initiatives.

The sixth and final chapter concludes the master's thesis document. The research process and significant findings are summarized.

2 APPLICATION INTEGRATION

This chapter includes a literature review conducted to build knowledge about software application integrations in general and to provide a background for interviews with the industry practitioners. The literature review was divided into two distinct themes according to research questions. These two themes are the success enablers in integration initiatives and obstacles which can hinder integration success. Several academic research databases were utilized such as Scopus, IEEE and ACM. Google Scholar web search engine was used to seek research articles too. The research also included a limited number of books written by industry experts. This chapter begins with a brief overview of software application integration in general, and the chapter continues with the success enablers and obstacles identified in the literature.

2.1 Overview of application integration

Several researchers in a field of Information Systems (IS) have recognized that integration as a term can confuse stakeholders, and it is often misunderstood. (Banaeianjahromi et al., 2016; Chowanetz et al., 2012; Kähkönen et al., 2014) Integration initiatives often include aspects of technology, company's business strategy and different stakeholders from the internal or external organization. Therefore, the integrations can be complicated, expensive and resource-intensive. Chowanetz et al. (2012) conclude that the term integration is derived from Latin integrare, and it is defined as "to make a whole".

Companies often rely on many different software applications and systems to run their daily business operations. The complex web of applications can include components from the several organizations, and therefore it is often necessary to integrate both internal systems and the external systems. Organizations have recognized that enterprise systems based on monolithic silos cannot meet continuously evolving business requirements and therefore, architectures such as service-oriented architecture (SOA) has increased in popularity. SOA represents an architecture design based on services. The services can be small software components providing a specific and reusable service or function. (Serrano et al., 2014)

There are many approaches to software application integrations, but according to Linthicum, (2004), they can be loosely categorized into four groups. These groups are information-oriented integration, business process integration oriented, service-oriented or portal-oriented integration approach. The most enterprise software integration initiatives are motivated by the need to share data between applications, either internally or externally in an organization. Therefore, most of these projects utilize information-oriented application integration approach. (Linthicum, 2004)

The application integrations are often massive undertakings, and it is critical to follow a rigorous process to mitigate risks of failure. (Linthicum, 2004) Building and managing information technology infrastructure used to be a central focus of companies' IT-operations in the past. However, many of these services are readily available as standardized offerings in the modern world. The quickly evolving technology platforms and service offerings are shifting an organization's information technology management towards managing and building many integrations between applications and systems. Companies often focus on the core business, and this approach might require purchasing standardized software, services and hardware from the external service provider. However, this requires integrations between applications and systems to form a unified system. The demand for integration professionals who understand both technology and business requirements are increasing. (Ragowsky et al., 2014).

Companies' motivations to integrate applications and systems vary. However, the shared objectives are to seek cost savings, to automate standard business processes, to create unique services by utilizing several different applications to form a coherent one application, to improve customer satisfaction and to improve general business performance. (Themistocleous, 2004). Linthicum (2004) concludes this by stating that most of the enterprise application integrations are driven by the requirement to share data between two or more applications. Enterprise application integrations can also extend the life of legacy applications, and it can enable methods to reshape business processes according to changing market requirements (Soomro and Awan, 2012)

The application integrations are often an essential enabler of business-critical processes. However, setting up a coherent, useful, scalable, secure, maintainable and well-documented

system is a significant task. It is essential to recognize that one objective of enterprise application integration is to provide methods and infrastructure for improved data sharing capabilities and therefore contribute to the success of all related business processes. The software integration complexity is increased by the heterogeneous application semantics, and therefore two or more systems can not automatically or easily share data. (Linthicum, 2004) The systems integration concept involves different internal and external software systems, their subsystems, knowledge and even skill aspects associated with the organization. Therefore it is a much broader concept than application integration. (Hobday et al., 2005). This thesis is focusing on the narrower concept of application integration.

According to (Ritter et al., 2017), there are three typical integration scenarios in a modern organization which are introduced in table 1. The scenarios are on-premise to cloud, cloud to cloud and device to cloud. Many organizations apply all scenarios. Some organizations still have significant resources invested in on-premise systems, and therefore, Ritter et al. (2017) agree that the fourth scenario is on-premise to on-premise application integration.

There are many different integration and related architecture styles, but the thesis is focusing on general styles recognized by the Solita Integration Manual, (2018). These integration styles can be loosely categorized into Point-to-Point-Integrations, Enterprise Service Bus (ESB) integrations & Integration Platforms and API based architectures.

Table 1. Typical integration scenarios (Ritter et al., 2017)

Integration scenario	**Description**
On-Premise to Cloud	Connecting packaged on-premise applications to cloud applications to extend capabilities, share data or connect with stakeholders
Cloud to Cloud	Connecting native cloud applications with other cloud applications to access new services, connect business partners or connect to service platforms
Device to Cloud	Connecting various devices to the cloud including mobile devices and IoT-devices to extend capabilities

Following section briefly describes integration styles, tools and frameworks which were deemed relevant in the context of the thesis.

Point-to-Point-Integration can be described as a direct connection between two applications enabling data sharing. It can enable business process improvement, but the method quickly leads to increasing system complexity, poor maintainability and technical debt. The Point-to-Point scenario is not preferred anymore since it can lead to messy spaghetti architecture. The complexity of the Point-to-Point- integrations tends to increase over the years. (Papazoglou et al., 2007; Solita Integration Manual, 2018)

ESB & Integration Platforms architecture design enable benefits such as better control, monitoring, maintainability and management compared to Point-to-Point-integration architecture. Applications share data and functions via centralized bus or via integration platform instead of only relying on application programming interfaces (API) between two applications. The enterprise service bus (ESB) category includes many different software alternatives. These products generally offer similar functionalities than lighter version integration frameworks, but many ESB products also offer additional features such as tools for deployment, monitoring and various administration tools. (Serrano et al., 2014)

Integrations can be implemented with the support of multiple different technologies and tools. Solita Integration Manual (2018) categorizes integration tools and technologies in three distinctive groups which are iPaaS (Integration Platform as a Service), EAI tools and Integration frameworks.

iPaaS (Integration Platform as a Service) is a relatively new concept compared to older integration application alternatives. According to (Ebert et al., 2017), the iPaaS solutions can offer high productivity, predictable cost and same mature EAI functionalities than more traditional integration platforms. These platforms can be roughly divided into two broad categories based on intended user groups. These categories are private users and enterprise users. The enterprise category includes many platforms geared towards smaller organizations as well as fully featured solutions for the most significant international organizations. For instance, FRENDS is eiPaaS (enterprise integration platform as a service) solution for both small and large organizations. (FRENDS-manual, 2020). The iPaaS products can be used to integrate applications hosted in different cloud platforms, to integrate cloud-based applications with the organization’s on-premise applications or the iPaaS can be utilized to integrate various on-premise applications. (Ebert et al., 2017)

iPaaS provider takes the responsibility of managing application infrastructure and maintenance, and this can be a significant motivation to implement a cloud-based integration platform. (Marian, 2012).

EAI tools (Enterprise Application Integration) includes a wide range of tools and technologies enabling integrations. According to Lam (2007), EAI tools generally consist of three main components which are integration broker, adapters and underlying information technology infrastructure. The broker component handles essential tasks such as translating messages, managing transactions and monitoring. The adapter can be considered as a gateway for different applications to communicate with each other. The infrastructure component is a foundation for all the communications.

Integration frameworks are technically a collection of software components or libraries which enable the development of necessary application programming interfaces (API) for the required development environment. This alternative is suitable for use cases which require a light-weight and relatively easy method to integrate one or more applications or systems. (Serrano et al., 2014) Apache Camel is an open-source integration framework for various use cases. It enables to transfer, routing and exchange of data between two or more applications or systems. (Apache Camel, 2020)

Serrano et al. (2014) highlight the importance of due diligence before engaging in integration development projects. Serrano et al. (2014) also divide modern integration options into three distinctive groups. These alternatives are integration frameworks, enterprise service bus (ESB) and integration suites according to figure 1.

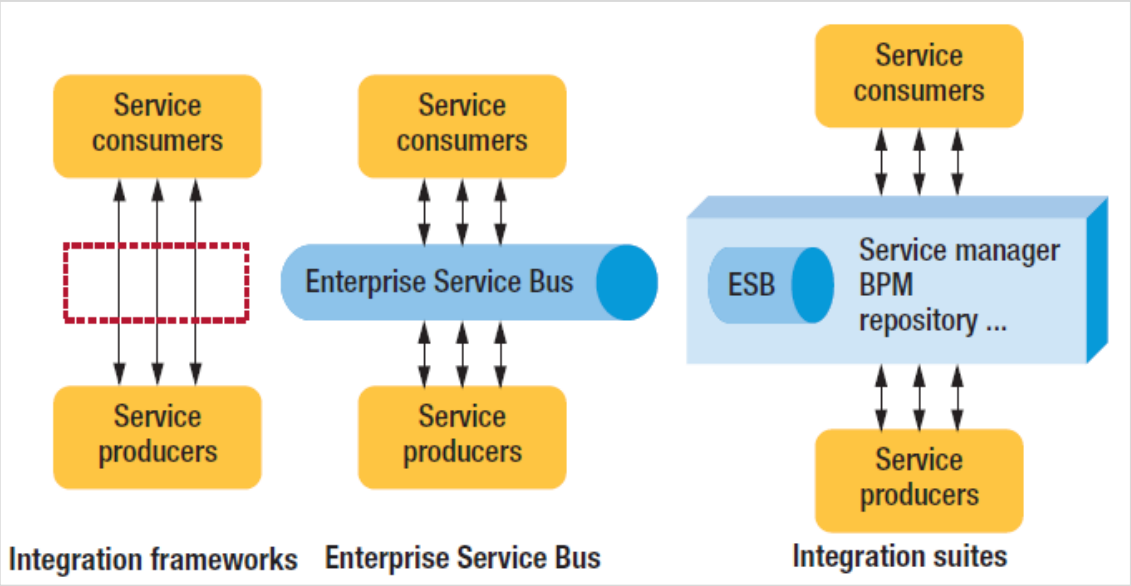

Figure 1: Three integration alternatives in SOA (Serrano et al. 2014)

2.2 Success enablers

This chapter introduces factors contributing to the successful integration outcome based on previous research.

Definition of successful application integration is relatively ambiguous since it depends on the set objectives and many integration initiatives include unique business requirements specific to only the given context. However, this thesis adopts the perspective of five success indicators introduced by Gericke et al. (2010). These indicators define a general guideline of what is considered a successful application integration initiative. Table 2 presents these indicators with a brief description. It is essential to recognize that application integrations are often implemented to satisfy business process requirements and to improve company performance. Each success indicator contributes to the overall success of the application integration initiative.

Table 2. Definition of success in application integration initiative (Gericke et al., 2010)

#	Success indicator	Description
1.	Achievement of target quality of business process support	The primary objective of the application integration should be to provide measurable business process improvements
2.	Achievement of user satisfaction	Most applications are used by humans, and therefore end-user's satisfaction is important
3.	Achievement of time to market goals	The successful application integration should lead to a productive and agile process
4.	Achievement of application architecture flexibility	The flexible application architecture enables rapid integration and disintegration of applications
5.	Achievement of application integration cost goals	The successful application integration should meet the cost objectives while achieving the other success indicators

The thesis research considers the success enablers as conditions, methods, practices, skills and resources which are recognized to contribute to the successful application integration initiative. There is a significant amount of research performed related to success factors in the general information systems area. However, according to Gericke et al. (2010), there are only limited amount of comprehensive studies performed in the specific area of application integration success factors. Lam (2005) researched critical success factors and their relations in application integrations, Gericke et al. (2010) identified 26 separate success factor candidates in previous application integration literature, and Kähkönen et al. (2014) studied general factors affecting ERP system integrations.

The identified 26 success factor candidates by Gericke et al. (2010) included factors such as usage of standards, integration expertise and modularization of logic. The research further grouped these 26 separate success factor candidates into seven success factor categories presented in table 4. The study also identified that all seven success factors do not share the same significance even though all factors were recognized as necessary. The research continued to identify success factors which have the most significant and broad impact for the successful application integration. Table 3 presents these four success factors. These are architecture management, organization maturity, consolidation of applications and technical infrastructure. Remaining three success factors were the use of methods, IT / business

alignment and SOA, but according to results, these had much less impact on the overall results. All seven success factors are included in table 4 complemented with the three other success factors identified by Lam (2005)

Table 3. The most significant success factors (Gericke et al., 2010)

#	**Success factors**
1.	Architecture management
2.	Organizational maturity
3.	Consolidation of applications
4.	Technical infrastructure

According to Gericke et al. (2010), success factors presented in table 3 have the most positive impact on time-to-market and cost of the application integration initiative.

However, it was recognized that further studies are required to confirm these findings, and the Gericke et al. (2010) states that the complex nature of most of the application integration initiatives makes identifying the success factors and their relationships a challenge. Gericke et al. (2010) suggest that their research participant's role bias, different perception of success criteria and the difficulties to recognize combined effects of multiple success factors can affect to results.

Lam (2005) suggest that ERP systems integrations initiatives share many similar success factors than other integration initiatives. Therefore, it is beneficial to include also ERP integration-related studies into thesis research within the application integration area. However, Lam (2005) highlights that enterprise-level application integration initiatives cannot be directly compared with general information systems projects. It is also essential to recognize that ERP systems are often monolithic, and therefore their approach to integration can be different compared to separate applications. (Lam, 2005). ERP systems primarily focus on standard business practices, but the one objective of enterprise application integration (EAI) is to provide options to customize processes for company-specific purposes. According to Lam (2005), one distinctive difference in success factors can be identified comparing enterprise application integrations and other general information

systems projects. The correct integration tools seem to be an important success factor in EAI which differs it from the general IS projects.

Lam (2005) identified three broad groups of critical success factors from previous literature related to enterprise application integrations (EAI) and including ERP system initiatives presented in table 4. Success factors were validated based on one large case study company in the financial industry. The most significant success factor groups were top management support, overall integration strategy and project planning and execution. These were further categorized into four groups, namely business, organization, technology and project.

Table 4. Integration success factors

#	Success factor	Description	Authors
1.	Architecture Management	Planning, measuring, controlling, adjusting, modeling	Gericke et al. (2010)
2.	IT/Business Alignment	Co-operation between different stakeholder groups	Gericke et al. (2010)
3.	Use of Methods	Integration methods are used with the integration patterns	Gericke et al. (2010)
4.	Organizational Maturity	Comprehensive & structured processes and documentation and general management	Gericke et al. (2010)
5.	SOA	Application logic implemented as separate and independent components	Gericke et al. (2010)
6.	Consolidation of Applications	Reduction of applications and utilizing packaged applications	Gericke et al. (2010)
7.	Technical Infrastructure	Infrastructure enabling application integrating including tools, standards and adapters	Gericke et al. (2010)
8.	Top management support	Strong business case and business alignment enables management support	Lam (2005)
9.	Overall Integration Strategy	Technology planning, company strategy alignment & business process change	Lam (2005)
10.	EAI Project planning & execution	Realistic project plans, customer involvement and appropriate tools & technologies	Lam (2005)

The application integration initiatives share many similar features, but at the same time, they can require a custom approach due to complex and customized business processes. The driver of integration projects often comes as a requirement from the business operations.

Gericke et al. (2010) approach application integrations as a long term and continuous development rather than project-based initiative. Also, other researchers have recognized the same long-term perspective related to ERP system integration. Therefore integrations require continuous improvements, maintenance and follow up. (Banaeianjahromi et al., 2016a).

Both Gericke et al. (2010) and Lam (2005) share the same view that individual success factors are not independent, and one success factor can affect others. According to Gericke et al. (2010), the formal IT processes and methods do not have the same importance than previously thought. It does not mean that processes and methods are not necessary, but the study suggests that loose guidelines for application integration initiatives offer the best overall results. It was also identified that common challenges related to IT and business alignment does have relatively little effect on the successful outcome within application integration. The same seems true with the SOA approach.

2.3 Obstacles

Enterprise application landscape is often complex web of applications and systems including on-premises applications, cloud applications, custom-built systems and various legacy systems. The overall complexity of the enterprise systems increases the likelihood of challenges in the new integration initiatives too. Linthicum (2018) claims that one of the common general information technology mistakes organizations make, is to move few applications to cloud services such as AWS or Google's platforms, but at the same time maintaining substantial resources based on the traditional data center approach. Balancing between two worlds increases the enterprise system complexity and therefore contributes to the integration challenges.

Several researchers agree that integrations are not only a technical challenge, but it involves many other socio-technical aspects too. Banaeianjahromi et al. (2016a) identified a total of

31 integration-related obstacles. Therefore, it is vital to recognize potential barriers and obstacles to increasing the likelihood of integration success. The research conducted by (Banaeianjahromi et al., 2016b) focused mainly to identify obstacles within ERP system initiatives and the 31 identified roadblocks were further categorized into four distinctive main themes. These obstacles were grouped into environmental, technical, managerial and organizational obstacles to capture broad research findings. Banaeianjahromi et al. (2016 b) emphasize the long-term nature of integrations which should be considered throughout the entire system lifecycle.

Even though Banaeianjahromi et al. (2016 b) confirm that integrations require a more long-term perspective, the implementation and deployment of integrations initially begin as projects. Therefore, it can be argued that it is beneficial to consider general IS-project failures and barriers to success also in the context of the thesis. Neglecting combined effects of potential obstacles during planning and project phase can lead to IS-project failures and therefore cause failures in integration development initiatives too. Goedeke et al. (2017) performed an extensive literature review, and the research team identified 65 failure factors in 23 publicly reported cases. These failure factors were further grouped into 13 failure categories according to table 5. Table 5 presents 13 failure factor groups, according to Goedeke et al. (2017) and a few distinctive examples of failure factors identified by the research.

It is recognized that most of the IS project failures are not caused by a single factor but rather the combination of several failure factors. (Goedeke et al. 2017) This finding emphasizes the importance of holistic project planning and due diligence. However, a failure to meet one project criteria does not automatically mean that the entire project is a failure. A failure criterion is specific to overall project objectives. Goedake et al. (2017) highlight that for instance, a project schedule target can be more critical if project objectives must meet legal requirements within a set timeframe, but the reaching a fixed schedule target can be less critical in other projects. Therefore, it is crucial to recognize the project-specific failure and success measures.

It is widely reported that the failure rate of IS-projects is generally high. There has been a slow improvement to these failure rates, but the failures remain relatively common. Daniels

and LaMarsh (2007) reported that IT industry failure rates are approaching 70 per cent and early research article by (Lyytinen and Hirschheim, 1988) claimed that at least half of all IT projects could be considered as failures. A comprehensive CHAOS- report (Group, 2014) reveals 31.1 per cent of software projects are cancelled before completion, and 52.7 per cent of projects exceed the budget of 189 per cent the original estimates. The IT industry projects have a better probability of failing than to succeed. However, as mentioned earlier, the measures of failure and success are ambiguous. The CHAOS report by the Standish Group (2014) further highlights that only 16.2 per cent of software projects meet their schedule and budget objectives in full. These figures are reportedly even worse in larger software development projects. Only 9 per cent of the larger companies' software projects meet their schedule and budget targets.

The application integrations are often an inevitable component of software and systems development initiatives. Therefore, it can be argued that the similar failure rates and failure factors potentially apply to integration projects as well as in other IS-projects.

The 13 failure groups presented in table 5 emphasizes the complexity of IS projects. The stakeholders must understand the different factors to mitigate the risk of project failures. Goedeke et al. (2017) also identified that even though IS project failure factors are broad, human actions have the most significant influence in project failure. It is also recognized that many failure factors have strong interdependency and therefore, lack of project management skills can have significant affect to several other factors such as planning, controlling, communication and contractor relationships.

Daniels et al. (2007) describe that the common IS-project failure factors in the previous research are related to lack of skilled employees, frequent changes in technology, various application constraints, poor project management practices and lack of comprehensive requirement engineering. The research team proposed that the complexity caused by extensive and changing project objectives is one of the primary root-cause of failure. Daniels et al. (2007) also highlight that the IS projects are complicated by nature and by their design.

Emam and Koru (2008) studied 18 cancelled IT-projects and the perceived reasons which lead to cancellations. The four most common reasons the organizations cancelled their IT

projects were identified as lack of senior management involvement, frequent requirements and project scope changes, lack of required managerial skills and finally budget overruns. The authors concluded that based on their research data, the failure rates vary from 26 per cent to 34 per cent in the IT field, which is lower compared to other figures discussed earlier.

Table 5. IS Project failure groups (Goedeke et al., 2017)

#	Failure factor groups	Few distinct examples
1.	Scope	technical complexity and large scale
2.	Planning	poor project planning and unrealistic estimations
3.	Requirements	conflicting, unclear and incomplete requirements
4.	Technology	unrealistic expectations, wrong choices and unknown technology
5.	Project process / controlling	insufficient testing, unclear development process and changes in project stakeholders
6.	Skills	lack of project management skills, lack of required skills and lack of overall business process understanding
7.	Contractor	misguidance, insufficient monitoring and changing contractors
8.	Contract	lack of contracting experience and unclear or missing definitions
9.	Change management	refusal to adopt new business processes and lack of end-user involvement
10.	Communication	lack of communication and coordination between stakeholders and unclear responsibilities
11.	Structure / Culture	weak IT department position and misfit between culture and project
12.	Stakeholders	lack of user commitment, lack of management support and too many stakeholders
13.	Environment	changes in the environment and problems in the environment

Soomro and Awan (2012) identified six common pitfalls in enterprise application integration initiatives based on previous research. These common pitfalls are lack of available skills, lack of understanding EAI as an architecture, neglecting aspects of security, performance and monitoring, mixing EAI with other initiatives and lack of comprehensive integration strategy. It was also identified that the company's internal politics and lack of communication could hinder an integration success.

Table 6 introduces 12 application integration barriers identified by the Themistocleous (2004). It was recognized that enterprise application integration (EAI) could have significant benefits. However, it is critical to consider potential barriers to mitigate the risks often associated with complex IS-projects. Themistocleous, (2004) claims that exceptionally high cost, high complexity, confusion in the integration marketplace and lack of technical skills were the most significant integration barriers. However, the barriers listed in table 6 are interdependent, and therefore, it is not easy to identify root-cause of the barriers. (Ho and Lin, 2004) agrees that implementing an integrated system is often very expensive and complicated.

Table 6. Application integration barriers (Themistocleous 2004)

#	**Barriers**	**Explanation**	**Category**
1.	Design cost	Redesign of business processes and structures is costly	Operational
2.	Complex system processes	Information systems are challenging to understand due to high complexity	Managerial
3.	Complex business processes	Complex business processes increase the overall complexity of integrations	
4.	Previous attempts	Poor success in previous attempts can hinder new initiatives	
5.	Politics	Various politics issues	Strategic
6.	Political impact	Various considerations such as who controls the business processes	
7.	EAI product issues	There are not a single EAI product to solve all integration-related challenges	Technical
8.	Lack of skills	Lack of employee skills in application integration scenarios	
9.	The high cost of EAI	Application integration cost is high	
10.	Change resistance	Organizational change resistance can occur	Organizational
11.	Lack of training resources	There is often a lack of time and other training resources	
12.	Cultural challenges	The multicultural environment can increase integration challenges	

2.4 Summary

Application integrations are complex and demanding development initiatives. However, most of the organizations must engage in integration initiatives to connect their

heterogeneous applications and to satisfy changing business requirements. Large organizations can have hundreds of systems, and therefore it can have a direct impact on the complexity of application integration initiatives.

The thesis research recognizes three prevalent integration scenarios which are on-premise-integrations, cloud-to-cloud integrations and device-to-cloud integration. However, there is still need for on-premise to on-premise integrations due to significant technology investments made in the past.

Point-to-point-integrations used to be a popular choice of integration methods in the past, but the approach created increasing complexity and maintenance disasters. Enterprise service bus (ESB) concept has evolved over the years, and the ESB can offer significant benefits compared to traditional point-to-point integrations. The ESB offers centralized control, monitoring and more straightforward system maintenance and development.

There are also several integration platforms and tools in the marketplace. The concept of integration platform as a service (iPaaS) aims to solve some of the problems related to more traditional integration platforms. The iPaaS tools enable organizations to focus on their core business operations since the iPaaS service provider is responsible for maintaining and improving the platform. Enterprise application integration is a concept including a variety of tools, methods and practices to enable useful integrations. Integration frameworks offer a relatively light version of integration services and tools. However, these frameworks then require more active development from the end-user organization.

Success factors are methods, tools, devices, practices, skills and strategies which enable successful integration outcome. The literature recognizes many interdependent factors. Gericke et al. (2010) identified four most crucial success factors which were architecture management, organizational maturity, consolidation of applications and technical infrastructure. Lam (2005) complemented these findings by adding three more critical factors which were top management support, overall integration strategy and EAI project planning and execution.

The integration obstacles consist of a broad range of problems, roadblocks, challenges and poor organizational and development practices which can hinder the success of integration initiative. The research identifies many potential obstacles which can hinder the successful application integration and the IS-projects in general. The IS-project obstacles were included since application integrations are often inseparable part of the application and system development initiatives. It is claimed that general IS-project obstacles and failures share similar features compared to integrations, and therefore it was deemed beneficial to include IS-project perspective.

According to Themistocleous (2004) high cost, high complexity, confusion in the integration marketplace and lack of integration skills are often significant barriers in the integration projects.

3 RESEARCH METHODOLOGY

The chapter describes the research methodology in the context of the master's thesis. The following sections aim to provide reasoning why a specific research method was selected, what were the research phases and how the data was gathered. The remaining section covers how data was analyzed, what were the primary ethical considerations and how potential threats to research validity and reliability were addressed.

3.1 Research process & design

According to Vilkka (2015), a research process can be loosely divided into five distinct phases. These phases are idea stage, commitment, execution, writing and publishing introduced in table 7. The column labelled as "Master's thesis Description" explains how the recommended research steps were applied in the thesis research.

Table 7. Recommended research process phases (Vilkka, 2015)

Research phases	General Description	Master's thesis Description
Idea stage	• Define the research problem, questions & scope • Define data analysis methods and other practices	• Research scope & questions defined with the supervisor • Discussions with the SASSE research team
Commitment	• Create a comprehensive research plan • Apply for research permits if applicable	• Research plan completed & approved 30.1.2020
Execution	• Gather & analyze the research data	• Industry practitioners' interviews as a primary data source • Thematic analysis of the data
Writing & reporting	• Write a research report & article • Discussion with the research participants	• Iterative writing process • Continuous reflection with the supervisor & team
Publishing	• Share research with the relevant stakeholders & publish results • Store research to relevant databases	• The thesis will be published in the LUTPub platform

The idea stage sets the foundation for the rest of the research initiative. A specific research problem and a set of research questions derived from the research problem forms the scope of the research initiative. The idea stage also includes a critical decision about the planned research method. It is essential to consider what are the research objectives and what kind of data would support successful research outcome (Vilkka, 2015). The thesis idea stage included several discussions with the thesis supervisor and with the SASSE research team to ensure that the thesis research objectives are well-aligned with the SASSE research objectives. The thesis scope was agreed to consist of two perspectives related to application integration initiatives in Finnish software companies. The research perspectives are perceived factors enabling successful integration and potential integration obstacles. A relatively short timeframe to complete the master's thesis required well-defined and narrow approach to this complex phenomenon.

The commitment stage follows the idea stage. This stage includes a vital research plan document describing all the critical aspects of the planned research project, and the document acts as a collective agreement between stakeholders. The research plan mainly describes agreed research questions, the research scope and schedules and potential financial aspects. However, it is often necessary to update the research plan, especially in a research project involving real-life participants. (Vilkka, 2015). The thesis research plan was completed and approved at the end of January 2020. It was also agreed that the research plan could be updated as necessary, but the primary research objectives should stay fixed. The thesis research plan did not require financial planning and the focus was to plan research questions, the research scope and to set a tentative schedule.

The execution phase is a practical data collection and data analysis phase, and it is based on the research plan. This phase can include data collection methods such as interviews, literature reviews and other data gathering methods. The execution phase also includes drawing conclusions based on the gathered data. (Vilkka, 2015) The thesis primary data collection method was agreed as semi-structured interviews conducted in Finnish software companies during Spring 2020. Chapter 3.3 describes data collection methods in detail.

The writing and reporting phase present the research project and findings in a written format. However, it is crucial to recognize that the writing is a significant part of every research

phase and the writing and reporting phase represent only the final form of the research documents. The writing begins with informal daily notes and diaries, diagrams, drawings and finally, the research is written as a formal thesis or a research article. (Vilkka, 2015) The thesis author began the writing process in early January 2020 by drafting informal literature findings and comments included in the research diary. The information drafts also included diagrams and mind maps created with the diagramming tools.

The final stage of the research is publishing final research documents and share the research findings with the relevant stakeholders. Depending on the research project, this phase can include participation in formal conferences and multiple briefings with the various stakeholders. The documents can be published in academic journals or other platforms. It is also critical to store all the research material according to agreements. (Vilkka, 2015). The approved master's thesis will be published in the LUT university's publication repository LUTPub.

The following section describes qualitative research methods in general and how these principles were applied in the thesis.

3.2 Qualitative research method

The master's thesis objective was to understand what the success enablers of application integration are and what are the perceived obstacles in these initiatives. Integration projects often involve complex socio-technical considerations from the perspective of multiple stakeholders. Qualitative research methods were initially developed for the field of social sciences to enable studying complex social and cultural phenomena. Human behavior requires flexible methods such as qualitative method. Many software engineering researchers agree that software engineering involves complex management, organizational and socio-technical considerations and therefore qualitative research methods are often the preferred method (Dybå et al., 2011)

Vilkka (2015) highlights the multiple benefits of qualitative research methods when studying complex social relationships, human behavior and how humans perceive their environment. The qualitative research method enables a flexible approach while collecting significant data

from various resources. Vilkka (2015 also recognizes that qualitative research methods do not provide absolute truths, but the findings are instead based on the researcher's interpretation of gathered material. Hirsjärvi et al. (2009) also point out that qualitative research objective is to understand how study subjects view their environment, how they behave and what are the motivations. It is essential to form a comprehensive overview of the phenomenon, but the aim is not to seek definite answers.

Hirsjärvi et al. (2009, 162-163) recognize 43 related qualitative methods and it was agreed that the common bond between each of the 43 qualitative research method is that they all highlight the significance of social phenomena, communication and culture in their natural context.

Figure 5 represents typical features found in qualitative research methods. It is essential to recognize that qualitative research method highlights humans as a primary research data source, the study can be inductive or deductive, data is often collected via semi-structured interviews or observations in a natural environment. Furthermore, the target group is selected based on the research area in hand. A qualitative research plan should be flexible, and adjustments are often required during the research initiative. The research findings should be considered as individual cases during data analysis. (Hirsjärvi, 2009)

Figure 2. Typical features of qualitative research (Hirsjärvi, 2009)

The master's thesis research approach meets the typical criteria of qualitative research methods. The primary research data is gathered via 20 semi-structured interviews of industry practitioners from 14 different software companies operating in Finland. Seventeen of the interviews were conducted as the face-to-face interviews and organized by the SASSE research team. The three remaining interviews were completed via an online platform. The thesis research involves studying human perceptions & behavior within the typical working environment in the technology field, and therefore the qualitative research method was deemed the most appropriate.

The research target group was selected based on multiple discussions within SASSE research team. Finally, it was decided that the target group includes Finnish software companies frequently involved in integration initiatives and projects.

The following sections describe the thesis data collection process in detail.

3.3 Data collection

The thesis research problem requires understanding real-life phenomena in a cross-functional environment. Therefore, the decision was made to utilize semi-structured interviews as a primary data collection method. Vilkka (2015, 122-126) recommends that structured interviews to be selected as data collection method if the research problem is relatively narrow in scope and the study involves describing a limited set of experiences such as people's opinions and experiences.

The semi-structured interview structure allows a flexible approach, and the participants can describe any required phenomena in rich detail. The interview questions are designed to answer the critical aspects of planned research interest. The order of questions is not as crucial as in a structured interview, and the researcher can give more freedom to the research participants to elaborate as necessary. However, the semi-structured interview process still follows pre-defined themes during the session. (Vilkka 2015, 122-126)

The structured interview method does not fit-well to the thesis research scope since the method offers only a little freedom to participants to explain and describe research subject in the real-life context (Vilkka, 2015). On the other hand, the unstructured interview method can potentially offer too much freedom and only little structure to gain suitable research data in this context. (Vilkka, 2015). Therefore, a semi-structured interview method offers enough freedom for participants to elaborate on complex situations. However, at the same time, the method provides enough structure to guide the interview process. Guest et al. (2012) confirm that qualitative data can be categorized into three groups such as audio, text or video format. The thesis primary data source is audio recordings transcribed into the text.

Vilkka (2015, 130) highlights the importance of the researcher's domain knowledge, broad understanding of the research target group and understanding of potential cultural aspects. The research participants are always reflecting their experiences, opinions and views through their cultural perspective and therefore, both national and company culture can have significant effects on answers. (Vilkka, 2015, 130)

The thesis data collection preparation began at the beginning of February 2020 by comprehensive planning with the SASSE research team. The planning included setting up initial themes for a semi-structured interview based on pre-defined SASSE research questions. The thesis research questions were aligned with the SASSE research questions. The following section describes the interview process in detail.

The thesis interview process was divided into five distinct phases, according to figure 3. The preparation, approach and interview phases were all completed as a collaborative effort of the entire SASSE research team. All interview records were transcribed by the Finnish service provider. The final phase of analysis and reporting begun immediately after the interview phase was completed.

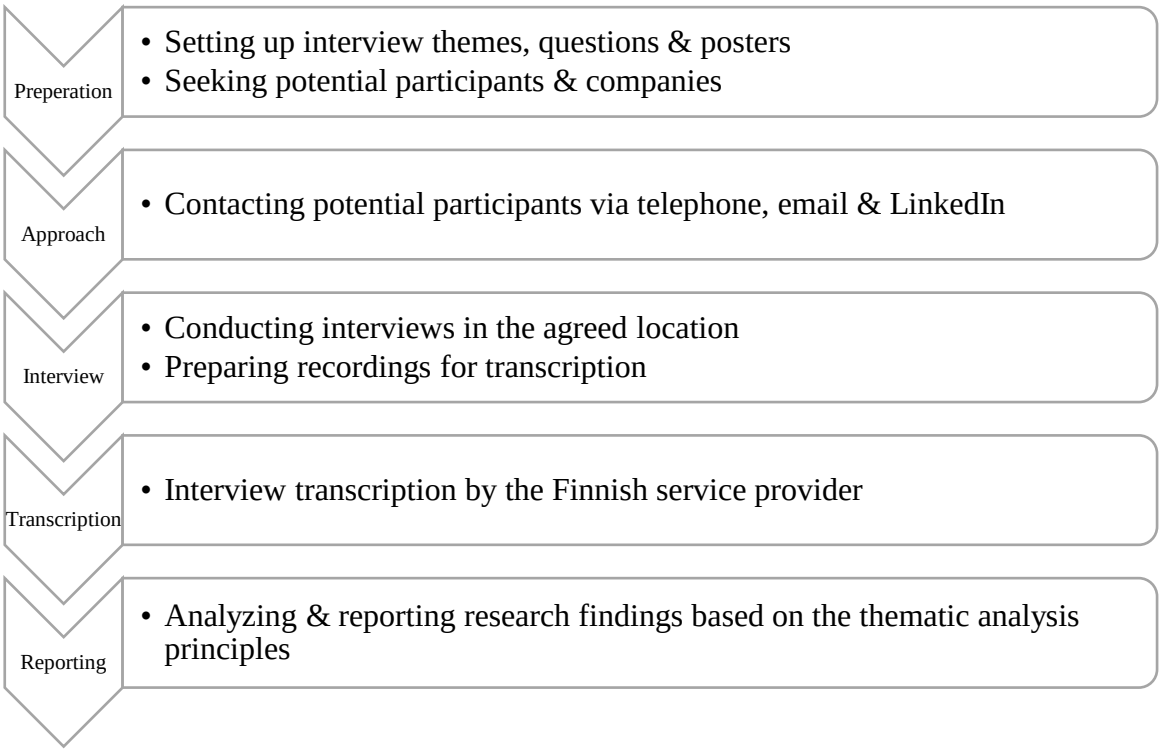

Figure 3. Interview process

Table 8 introduces the SASSE data collection goals versus actual figures. Key performance indicators (KPI) enable evaluating research performance. The same interview data was utilized in the thesis project, as well. The research team agreed with the goal of 20 research interviews at the beginning of February, and the plan was also to interview two industry practitioners in each company. The team was able to reach the goal of 20 interview sessions in total, but it was not possible to reach the target of two practitioners from each company. However, this minor issue was compensated by the larger number of unique companies involved. The interviews were completed according to the set target schedule.

The objective was to hold each interview face-to-face with the research participant to ensure ideal personal interaction. Seventeen interviews were conducted in person and mostly in the participants' office, but the global pandemic of Covid-19 forced research team to conduct remaining three interviews via alternative means. The Microsoft Teams video conferencing platform provided an alternative solution for the remaining three interviews.

The thesis research material included 20 interviews from 14 separate software companies operating in Finland. The interviews were recorded in MP3 audio format and then later

transcribed in verbatim (word-for-word) by the professional Finnish transcription service provider. Mean length of the interviews were 69 minutes, the shortest interview record was 40 minutes, and the longest one was 1 hour 58 minutes. A typical 69 minutes interview audio transcribed in verbatim includes approximately 8400 words.

Table 8. Interview goals

KPI	**Goal**	**Actual**
Number of interview sessions (N)	20	20
Number of unique companies	10	14
Interviewers	3	3
Interview schedule	February / March 2020	First 31.1.2020 Last 3.4.2020
Estimated interview length	60-90 minutes	69 minutes (median)
Interview method	20 face-to-face	17 face-to-face 3 Teams

However, the most important thing is that transcripts hold meaningful information, and they provide enough accurate description of the interview content. (Braun and Clarke, 2006). The completed interview transcripts were easy to read, well-structured, and they contained broad descriptions of integration experiences.

Table 9 presents interview participants' professional roles during research interviews (RI-#). The interview order does not represent an actual schedule, and some roles are slightly modified to protect the participant's anonymity.

Table 9. Interview participants

#	**Interviewee Role**	#	**Interviewee Role**
RI-1	Director of Consulting Services, Managing Consultant, Founder	RI-2	Consultant
RI-3	Integration Consultant	RI-4	Cloud Platform Lead
RI-5	Senior Managing Consultant	RI-6	Senior Developer
RI-7	Lead Developer	RI-8	Head of Business Development
RI-9	Key Account Manager	RI-10	CTO
RI-11	Full-stack Developer	RI-12	CEO
RI-13	CTO	RI-14	Business Area Director
RI-15	Lead Enterprise Architect	RI-16	Software Architect
RI-17	Senior Consultant	RI-18	Managing Consultant
RI-19	Director, Software & Services	RI-20	Developer

3.4 Thematic analysis

The collected research data for the master's thesis was analyzed based on the principles of the thematic analysis. Thematic analysis is one of many forms of qualitative research methods. The thematic analysis is a flexible research method that can be utilized in different research fields, and it can provide significant advantages, especially in a diverse research setting (Maguire and Delahunt, 2017). The method offers guidelines for identifying, analyzing and finally reporting specific patterns or themes recognized within the data set. This method helps the researcher to interpret different aspects and perspectives of the given research area. (Braun and Clarke, 2006). The thematic analysis is frequently utilized in software engineering related research initiatives, and therefore it is especially suitable for this thesis. (Cruzes and Dyba, 2011).

The thematic analysis is not bound to any theoretical framework, and this is one of the differentiators compared to other analytic methods such as grounded theory. (Braun and Clarke, 2006; Maguire and Delahunt, 2017) The grounded theory approach shares similar features compared to the thematic analysis since the grounded theory approach also seeks to recognize patterns within data, but the grounded theory is theoretically bound. (Braun and Clarke, 2006). The flexibility offered by the thematic analysis method makes it the ideal fit to analyze broad research data included in the thesis. According to Braun and Clarke (2006), the thematic analysis is an excellent research method choice for especially researchers building their core research capabilities and this statement also support the method's suitability for the thesis research project.

Table 10 presents the advantages of thematic analysis method, according to Braun and Clarke (2006). Table 10 also reflects the benefits identified in the thesis research. The most significant benefit was the flexible nature of the thematic analysis since the research data included a broad range of data from different professional perspectives. The flexibility enabled the researcher to adapt research method to fit the current research problem while the thematic analysis provided a necessary guideline. It was also recognized that the thematic analysis is relatively easy to learn and therefore, suitable for building student's research capabilities. The research data included a large amount of interview data, and therefore the thematic analysis method was useful to identify and summarize the core content.

Table 10. Benefits of thematic analysis (Braun and Clarke, 2006)

Advantages	Advantages identified in the thesis
Flexible method	Yes
Relatively easy, quick to learn and accessible method	Yes
Results easily accessible to the general population	Not applicable
The method can be used in participatory research	Not applicable
Summary of large data sets	Yes
Highlighting similarities & differences in research data	Yes
Unanticipated insights	Yes
Social & psychological data interpretation	Yes
The method can be used for other qualitative methods	Not applicable

Braun and Clarke (2006) suggest that the researcher should make several research approach choices before fully engaging with any specific research analysis. These choices are introduced in the following section. Figure 4 represents thematic analysis choices made during the master's thesis. It is essential to recognize that thematic analysis is a flexible research method. Therefore, the approach does not need to be strictly limited only one type of perspective during the research project.

The thesis research questions were set before engaging in thematic analysis, and therefore the primary approach to pattern-seeking was selected as deductive according to Braun and Clarke (2006). The deductive approach is more suitable if the researcher aims to seek patterns based on specific research questions or research interest. This approach objective is to find patterns fitting to research questions, and the researcher codes data based on a relatively narrow focus. (Braun and Clarke, 2006)

The next research design decision is related to epistemology. Braun and Clarke (2006) loosely categorize thematic analysis in three separate approaches which are essentialist, constructionist or contextualist according to figure 4. The thesis approach was selected as essentialist since the research studies individual motivations, experiences and meanings of software industry practitioners. According to Braun and Clarke (2006), the essentialist or realist approach assumes that communication and meanings are relatively straight forward,

and there is a linear connection between meanings, experiences and language of research participants. The constructionist approach is not suitable for seeking individual motivations, and the contextualist approach is a mix of both approaches. (Braun and Clarke, 2006)

Finally, Braun and Clarke (2006) recommend that the researcher should decide whether to seek patterns based on the semantic approach or based on the latent approach. The semantic approach to pattern-seeking or recognizing themes aims to identify the explicit meaning of data found in the research material. The latent approach aims to "dig deeper" than identifying the surface meaning of data. The latent approach includes more data interpretation compared to the semantic approach. (Braun and Clarke, 2006) It was decided that the semantic approach fits better for pattern-seeking approach since the strict thesis timeframe does not allow extensive interpretations and reflections.

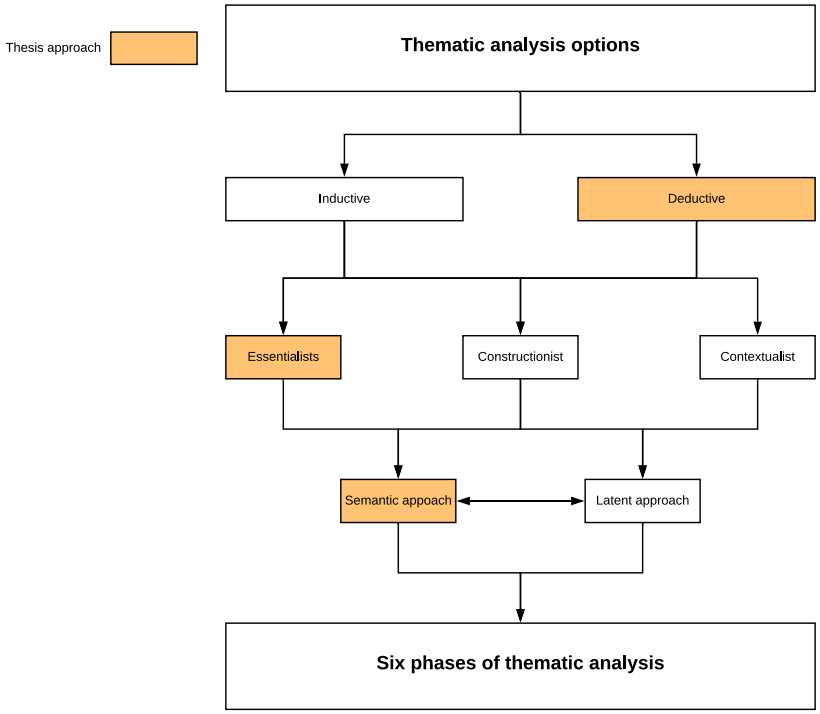

Figure 4. Thematic analysis options (Braun and Clarke, 2006)

Braun and Clarke (2006) recommend the following six distinctive phases during thematic analysis. The process is a highly iterative and continuous review of each phase is necessary to meet research objectives. A figure 5 presents these research phases, which begins reading carefully through the material, and then continues with the generation of initial codes,

searching initial themes, reviewing the themes and defining and naming the final themes. The process ends with a comprehensive written report.

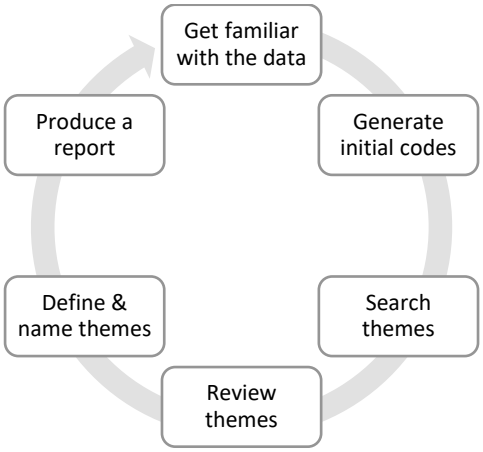

Figure 5. Thematic analysis process (Braun and Clarke, 2006)

The following sections describe each of these recommended thematic analysis steps by Braun and Clarke (2006) and how these phases were applied to the master's thesis research.

The get familiar with the data- phase involves a thorough reading of collected research data. Braun and Clarke (2006) emphasize the importance of active reading process. The researcher must immerse him/herself into collected data to form a comprehensive understanding of available data. The immersion process requires continuous reflection, and the researcher should already start seeking initial patterns from the data. Braun and Clarke (2006) recommend that the researcher reads the entire data corpus at least once before engaging any further steps in a thematic analysis process.

Each of the 19 research interview audio records was first listened carefully by the author at least once while taking notes and recording initial reflections. The remaining one interview did not include an audio transcript, but only written notes. The next step included the active reading of all 20 interview transcripts while taking down complementary notes. It was recognized during the initial reading that the common theme was related to communication challenges between different stakeholders. Terminology such as external integration and external service confused participants too. Research findings are described in detail in chapter 4.

The generate initial codes- phase involves rereading the transcripts, but this time objective is to generate short descriptions of any interesting content and assign them a code or label. The codes should identify meaningful, interesting and relevant feature found in the research data. (Braun and Clarke, 2006) The thesis research transcripts were coded by utilizing software application Atlas.ti 8. Each 19 interview transcripts were code broadly around two research questions, and the coding process aimed to identify relevant content regarding the enablers of successful application integration and potential obstacles in these initiatives. The process was highly iterative, and it was necessary to start from the beginning several times to limit the risk of scope-creep. The iterative approach also allows the repeated reflection of the validity of codes. The initial coding process resulted in a list of 266 separate codes. The initial code-list included many closely related or overlapping codes which were merged to form one code. Several codes were also later deemed irrelevant based on research interest in this thesis research project, and these were deleted.

The search themes- phase involves identifying potential patterns within created code groups. The themes are generally broader concepts than codes. The researcher can also create visual maps to draw conclusions and connections between different codes. (Braun and Clarke, 2006). The searching themes is a demanding phase since the long list of heterogeneous codes can be overwhelming. The initial coding process resulted in a list of 266 separate codes. However, it was relatively easy to recognize the most relevant themes. Code groups were exported to Microsoft Excel and formatted as a filtered table structure to ensure more straightforward modification and data filtering. Each data extract was carefully read through again, and broad initial themes were assigned for each data extract.

The review themes- phase begins when a researcher has identified initial themes from the data set. Commonly, some initially found themes do not make sense after the review process, and some themes must be deleted or merged. The researcher must consider, is there concrete evidence within research data to support a specific theme. Sometimes a specific theme seemed significant at the beginning of the process, but later it was deemed irrelevant or not significant. (Braun and Clarke, 2006)

The author spent a significant amount of time reviewing the identified themes. The initial list of themes was not coherent enough, and the decision was made to focus on a few significant findings which were supported by the research data. This review process resulted

in a simplified list of themes and few sub-themes. Braun and Clarke (2006) also warn that reviewing and reflecting process can go on for too long, and therefore it is the researcher's responsibility to recognize when it is time to stop the review process. The thesis review themes process was concluded when the author recognized that new reviews did not offer additional information, and therefore the review was comprehensive according to Braun and Clarke (2006).

The define and name themes is a final step in actual data analysis, and the researcher should consider what each theme represent based on relevant data extract. The theme name should accurately reflect and describe the data collected under each theme. The phase also includes the final organizing of data extract and ensuring that all data extracts can fit into their identified theme. (Braun and Clarke, 2006). The thesis author reviewed theme names multiple times to capture the essence of the specific finding group. The process was highly iterative, and the theme names were reviewed even during writing a final report.

The produce a report- phase concludes the thematic analysis process, and it includes final analysis and reflection of collected data extracts and collated themes. The researcher should also present relevant data extracts to offer the reader a better view of the collected data. (Braun and Clarke, 2006). This phase was completed during May, and early June 2020 and chapter 4 introduces the significant research findings in each theme category. The data extracts from the interview transcripts were inserted into the text to offer proof of research findings and to illustrate specific phenomena.

3.5 Ethical considerations

The research data from interviews can include sensitive or confidential information regarding participants or related to company trade secrets. It is the utmost priority to ensure confidentiality during every research project from the beginning until the end of the project. DiCicco-Bloom and Crabtree (2006) list four primary ethical considerations related to research interviews. The research team should ensure that there is no harm caused to any research participants, the interviewees' information must be protected, the researchers must explain clearly, and thoroughly the nature of the research study and the research team should

reduce the risk of any exploitation. These ethical considerations are especially crucial if the research studies sensitive personal matters or trade-secrets. However, every research must follow these best practices.

Finnish National Board on Research Integrity (TENK, 2020) has published several comprehensive ethical frameworks and guidelines for any researcher to follow. The authority lists nine critical considerations which every responsible research initiative should follow. Table 11 introduces these considerations, which were also followed during the thesis research.

The SASSE project guidelines and the thesis project were aligned at the beginning of January 2020 to ensure that the research processes meet the general good research practices, the good data acquisition and analysis practices and to ensure that the entire thesis follows guidelines introduced in table 11.

Each research interview conducted within the thesis and SASSE project begun by clearly explaining the interview process to participants and to offer interviewees option to withdraw any information deemed necessary or to stop the interview process at any time. The research participants were also promised that all collected data is available only for authorized research team members, and all published results are anonymized before publishing.

Research interviews were recorded with the two Olympus audio recorders and audio records were transferred securely to the SharePoint platform administered by LUT University. All research related material is stored securely in the same SharePoint platform. Data backups are handled by the LUT University. Only the five members of the SASSE research team have access to data stored in the project folders.

Table 11. Ethical research considerations (Finnish National Board on Research Integrity)

	Ethical research consideration	Explanation
1.	General good research practices	Integrity, meticulousness, accuracy, honesty
2.	Data acquisition & analysis	Conforms to scientific criteria and ethically sustainable
3.	Give credit to authors	A researcher must give credit to authors and their work used in the research
4.	Scientific standards	The researcher must comply with high standards in planning, conducting research and reporting
5.	Research permits	Acquire necessary research permits before beginning a research initiative
6.	Research team agreements	The research team must agree with their rights, responsibilities, obligations and any other open questions
7.	Transparency	Sources of financing, commitments, conflict of interests relevant to research must be revealed
8.	Conflict of interest	Researchers must ensure that they do not have any conflict of interests before any evaluation or decisions
9.	Good personnel practices	The research organization must follow proper personnel and financial administration practices and ensure data protection

3.6 Validity & reliability

Every research includes concerns about validity and reliability. These are essential indicators of research quality. The research reliability includes considerations of how consistent research results are if the research process would be repeated by a different researcher. The research validity indicates the accuracy of the research findings and does the research process provide answers to set research questions. (Hirsjärvi et al. 2009, 231-233)

There are many contributing factors to the research validity and reliability, and the researcher can mitigate the risks by careful planning and well-organized research process. The research participants may provide inaccurate information or even false information. Sometimes research participants do not understand interview questions and can provide out of scope information. However, single inaccurate information within extensive data set seldom

causes a false research outcome. These potential inaccuracies must be recognized during the research process (Vilkka 2015, 194)

The research validity and reliability were considered during the thesis research. The research data was collected primarily via semi-structured interviews, and the interviews were conducted in a natural office setting. The interviewees did not receive interview questions in advance, and therefore there is a risk that some research participants made inaccurate statements regarding specific integration technologies, methods or processes. The confusing integration terminology can contribute to the risk too. The confusion about the integration terms is identified in several previous research. (Banaeianjahromi et al., 2016b; Chowanetz et al., 2012) Potential conflicting information was considered case by case and omitted as deemed necessary. The thesis research objective is to recognize and report individual human experiences in a natural working environment, and therefore the results are not necessarily applicable in any other environment. Human perception tends to vary over time, as well.

4 IDENTIFIED INTEGRATION ENABLERS & OBSTACLES

This chapter presents significant findings based on the 20 semi-structured interviews conducted by the SASSE research team. The first section covers factors identified having a positive impact on a successful outcome. The second section continues with the perceived obstacles having a negative impact and to potentially hinder the successful integration initiatives. Complete tables of enablers and obstacles can be found in the appendix section.

4.1 Integration success enablers

A successful integration initiative requires cross-functional co-operation, management and broad technical skills. Figure 6 presents a high-level overview of significant success enablers found in the research interviews. The findings were divided into three major groups to emphasize that application integration initiatives involve aspects of people, process and technology. Each of these three aspects affects each other, and therefore it is essential not to neglect any of them. Probability of successful application integration is increased when all three aspects are in harmony, and all of them support the organization's integration objectives.

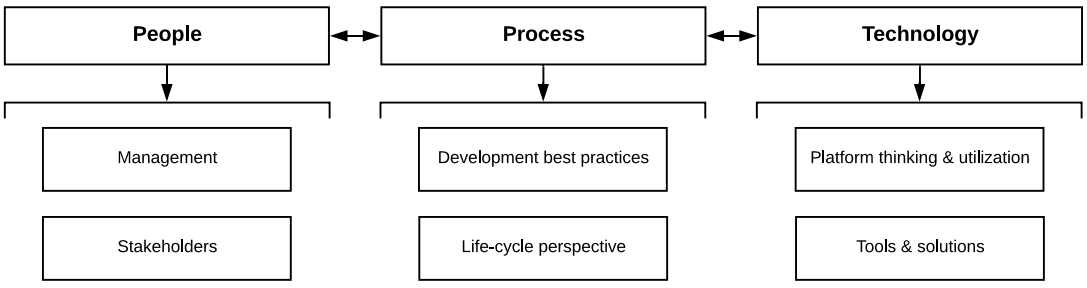

Figure 6. A high-level overview of integration enablers

Application and system integrations are implemented to create additional value for the organization and the customers. Motivations to implement these complex and resource-intensive initiatives should come from the actual business demand, and the management should provide support and resources for the development organization. The integrations enable business-critical functions, and therefore the integrations are often vital for the

success of the entire organization. The successful integrations can also enable new features and functions for more effective business processes:

> "*The organization utilizes systems to perform business-critical tasks, and the systems are often operated via user interfaces. The end-users gain complementary features and functions due to the effective integration of several applications. These complementary features would not possible without application and system integration" (Lead Enterprise Architect)*

Technology is an essential component in nearly all business operations. Organizations consist of people, and therefore it is vital to recognize the impact of human behavior on every integration and other technology initiatives. The interview transcripts were coded based on the thematic analysis method, and people aspect was emphasized by all interview participants. The people aspect has a significant impact on both the success and failure of integration initiatives. It is recognized that people, process and technology groups are partially overlapping, and several themes could be categorized into two or more group. It is also equally important to understand that integration initiatives require continuous interplay between people, process and technology.

The interview participants indicated that it is crucial to perform enough due diligence before trying to implement new integrations, and therefore, the management role is emphasized within success enablers. It was suggested that this due diligence phase should involve:

> *"high-level abstract consideration in a context of company business operations, value proposition and what are the organization's priorities". (Lead Enterprise Architect)*

The high-level view enables then conclude that what are the business objectives of the integration, and many participants emphasized that application and systems integrations are implemented to provide additional business value for the company and the customers.

The following section introduces six broader success enabler themes identified based on 20 research interviews. These themes are management, stakeholders, development best practices, life-cycle perspective, platform thinking & utilization and tools & solutions.

4.1.1 Management

Management theme was further divided into four separate sub-themes which could be considered as management related. These sub-themes were formulated as governance & management competencies, project management, SMART goal setting and value focus according to table 12. The SMART goal is an acronym of specific, measurable, achievable, relevant and time-bound. (mindtools.com, 2020).

Table 12. Management

Sub-theme	**Theme**
Governance & management competencies	Management
Project management	
SMART goal setting	
Value focus	

Governance & management competencies sub-theme was used to capture participants views that organization's management has a vital role in ensuring that application integration support company's overall development strategy and to provide measurable business value for customers and users. One participant concluded this by stating:

> *"The ideal situation would be that our customers would learn to lead their business development, and they would also understand the significance of information technology within their strategy. This overall understanding would support mutually beneficial business relationships between the service provider and the purchasing party." (Lead Enterprise Architect)*

It is essential to recognize that especially the management theme has a significant impact on all other themes. Therefore, the management is a critical factor in both success and failure.

The application integrations enable business-critical processes, and several research participants highlighted that:

> *"All stakeholders must understand the level of business criticality within application integration initiatives" (Director of Consulting Service)*

This finding highlights the importance of management role, ensuring that a broad group of internal and external stakeholders must understand why integrations are implemented and what are the potential business benefits. It was also suggested that a product owner could help top management to formulate strategy considering a company's value proposition and what are the optimal solutions to meet these objectives.

Project management is another sub-theme of broader management theme. The project management practices are still essential success enablers while developing new integrations, even though integration initiatives also require complete life-cycle perspective:

> *"These days, the continuous development model is more common in integration development. … "It is not a project model [in integration initiatives], but it is rather based on continuous development, the agile model actually" (Business Area Director)*

Kähkönen et al. (2014) confirm this finding by stating that "integration remains a continuous challenge which is never fully achieved due to the constantly changing business requirements and organizational landscape".

An experienced project manager is often a crucial link between the integration development team and the business leaders. A qualified project manager can filter conflicts and ensure that the development team can focus on delivering an integration service that meets the customer and end-user expectations. An experienced project manager is especially crucial in sizeable consortium-based development initiatives, as highlighted by one research participant:

> *" The consortium of our customer has hired an external Project Manager or consultant who was a collective voice and a chair. They organized this well when*

there was a need to make decisions; they were able to agree… and then finally this Project Manager told us [vendor] that this is the way it is done; this was an outstanding practice" (Key Account Manager)

SMART goal setting sub-theme captures the perceived importance of specific, measurable, achievable, relevant and time-bound goal setting. The companies seek measurable business benefits and process improvements from their integration initiatives, and therefore it is essential to spend significant resources to set goals accordingly. Several participants recommended that organizations should set clear and measurable integration objectives before spending resources in the actual integration project:

" You should figure out what are you planning to do before engaging in any integration activity and find out how you can measure your progress. Moreover, how you can measure success?" (Business Area Director)

Integration initiatives often involve multiple stakeholders and therefore, multiple priorities. Project management should ensure that agreed tasks and requirements from different stakeholders do not cause conflicts or even block each other.

" Objectives should not block or conflict each other" (Senior Consultant)

Successful integration schedule planning requires that each stakeholder understand the realities, action items are well-planned and necessary monetary budget is pre-approved. Several research participants mentioned that it is common that management does not fully understand that the integration implementation can be time-consuming and resource-intensive.

" [Integration project enablers] If we are talking about integration project, the realistic schedule and well-planned and approved budget" (Senior Managing Consultant)

Value focus sub-theme emphasizes the importance of identifying measurable business value from the integration initiatives. Measurable business value can also increase management support and ensure that the necessary resources are available.

> *"The summarize [integration], it enables automatic data transfer between separate systems and the objectives to include easy, elastic and secure data transfer. Manual data transfer can be more insecure and labor-intensive. These are the main reasons why integrations are implemented" (CEO)*

Comprehensive business intelligence is not possible without integrated systems, and the integration can enable that data from different sources is collected, presented and finally analyzed in one central system.

> *" Business intelligence requires that the data from all these systems is gathered to one central system [via integrations] and it is analyzed" (Azure Lead)*

It is also essential to recognize that the integrations can enable unique products and services by combining features and functions from several different source system. The research participants also commented that effective utilization of external services via integrations allows companies to focus on their core business area. Therefore, integrations can improve the organization's overall business performance significantly.

> *" Integration enables added value creation for our service, and we can build features that other companies [or products] do not have. To make better services. On the other hand, integrations are necessary because we cannot do everything in-house and it is not even feasible. […] We can save resources [by utilizing integrations to other services], and it enables us to focus our core business, and by combining several [external] resources, we can create something unique and be better than our competitors" (Senior Software Developer)*

4.1.2 Stakeholders

The stakeholders theme was further divided into four separate sub-themes introduced in table 13. These sub-themes are technical & cross-domain skills, active collaboration,

mutually beneficial relationships and active communication. The following section presents these sub-themes and extracts from transcripts.

Table 13. Stakeholders

Sub-theme	Theme
Technical & cross-domain skills	Stakeholders
Active collaboration	
Mutually beneficial relationships	
Active communication	

Technical & cross-domain skills sub-theme includes perceived critical organizational skills and knowledge. Integrations often affect the workflow of the entire organization, and therefore, the development team must have cross-domain skills to complement strong technical skills. At a minimum level, they should have easy access to confirm and clarify any doubts. The integration success requires technical skills but equally important is to understand the effects of technical implementation in the context of the entire business ecosystem.

> *"you [employee] need to understand modern and legacy interfaces and standards, you need to know how JSON is constructed, you might want to know a little bit of JavaScript… and REST JSON, XML, XSLT… Then finally process knowledge" (Business Area Director)*

The data sources must be clear, how to access them and especially how to utilize the data for the success of the project.

> *"Employees who know where the data is stored, how to access it and how to translate the business requirements for the system." (Business Area Director)*

Active collaboration sub-theme was set to capture research participants' notices about the teamwork and co-operation. The integration motives often originate from the business organization, but the technical organization is the implementor. This cross-functional nature of the integration requires excellent communication, trust and respect between stakeholders.

"The target should be that the business side of the organization is involved as much as possible and if the businesspeople co-operate well with technical people, then generally [integration initiatives] everything goes smoothly" (CTO)

Mutually beneficial relationships sub-theme includes research findings which emphasize the importance of ensuring value provided for all stakeholders. The co-operation can be considered mutually beneficial when all parties can agree that the implemented integration offers significant benefits and all parties are satisfied. Extract from the one interview summarizes this well by stating:

"I would like to seek solutions that both parties can be proud of the results, and they can both agree that now it is good [system integration]" (CTO)

Active communication sub-theme includes essential research findings regarding cross-organizational communication. The business organization often provides financial resources to implement integrations, and they control other resources too. It was perceived critical success enabler to ensure that integration development organization has close relationships to the external business organization. The integrations cannot be implemented only based on strict financial calculations, and often upper management does not fully understand the technical requirements.

"Maybe I could say that it is important to ensure [good] relationships to upper management to ensure that [integration] decisions are not made only based on figures" (Managing Consultant)

The integration initiatives are complex and often require relatively long development phases. Easy access to decision-makers can help to clarify doubts swiftly, and the development team can make necessary corrections.

"Direct communication channel enables daily clarifications as necessary" (CEO)

4.1.3 Development best practices

Application integration is often part of a more extensive software and system development process, and therefore many of the same practices apply. It was identified that the development best practices have a significant role in the successful integration initiative. The development best practices theme was further divided into eight separate sub-themes according to table 14. The broad range of research findings required several sub-themes.

Table 14. Development best practices

Sub-theme	Theme
Loose coupling & high cohesion	Development best practices
Follow & encourage standards	
Testing & prototyping	
Simplicity & usability	
Agility	
Comprehensive requirements engineering	
Relevant & usable documents	
Security	

Loose coupling & high cohesion is one of the general good practices in software engineering and not only in the context of application integrations. The coupling can be described as how tightly or loosely software components and subcomponents are interdependent. Generally, loosely coupled is preferred and therefore, software components are not highly interdependent. On the other hand, the cohesion can be described how specific functions each sub-component performs. The high cohesion is preferred, and therefore different subcomponents perform only particular functions related to the same components. (Gui and Scott, 2006). It can be argued that these same principles affect application integration schemes as well since it is vital to ensure that data flows and functions during integrations follow the same general software engineering best practices. The well-designed integration enables continuous system development and integrations are loosely designed according to this research finding:

"The good integration is created so that it does not limit system development, i.e. the integration should not be tight" (CTO)

Follow & encourage standards sub-theme captures the importance of standards utilized in development, testing, deployment and operation. Common standards enable easier integrations between separate systems, and therefore organizations should encourage following them within every development initiative when applicable.

"Standards are especially important in these integration platforms, ... open standards, OpenAPI's and other communication standards should be encouraged to use as a de facto standard, […] we should support this" (Business Area Leader)

Testing & prototyping sub-theme emphasizes the importance of testing application and system integrations thoroughly before deployment to production. Many integrations are often business-critical, and therefore it is vital to spend enough resources in this phase. One research participant concluded this by the statement that:

"The ideal situation, in my opinion, is that there should be three levels of [application/system] environments which are testing environment, quality analysis environment and production environment" (Integration consultant)

The testing environment is important, but it is equally essential to have comprehensive testing processes in place.

"If we could follow development pattern such as test-driven development, which is of course quite demanding for the customer… It can also be a little bit more expensive at the beginning, but think about how many times you should automatically test all these interfaces […] It would be super smart" (Business area director)

It is also recommended to spend a significant amount of time to seek available alternatives, create possible proof-of-concept models and to compare risk factors of each alternative:

"First of all, it is preferred to consider if something [product feature] is necessary at all, or could we somehow just go around [the required feature], instead of immediately rushing for development… to spend some time to compare available alternatives and also consider potential risks" (Senior Developer)

Simplicity & usability sub-theme includes research findings related to the importance of keeping system design as straight forward and as simple as possible. Simple design often equals usable design. The simplicity reduces the point of failures, and the potential system faults are easier to locate. The system should enable users to perform intended actions, but the additional features should be limited. One research participant views that simple technical design and simplicity is always preferred over intricate designs:

"First of all, the system does what it was planned, and the technical design should be as straight forward as possible. It is never a plus point if the system is very complex and fancy. The simplicity just works" (CTO)

It can be argued that the most usable system contains all the necessary functions to support end-users' targets. However, the system is kept as simple as possible by removing everything else.

"If we can decide, we would rather keep it [the product & service] simple by removing all the unnecessary functions. We would rather do things by configuration rather than coding" (Lead Developer)

Agility sub-theme describes the notion that business requirements and operating environment are in constant flux. Extensive application and system integration initiatives can span for an extended period due to complex systems and due to a large number of integration components. Therefore, the integration development process must enable re-aligning objectives as required. The development organization should plan change processes. The agile integration development process was recognized as one of the essential success enablers:

"We must be prepared for changes [in requirements] […] when we are prepared in advance that requirements can change in the middle of the project… then we are not in trouble" (CTO)

Stakeholders business requirements can change in the middle of integration project delivery, and it was identified that development organization's failure to plan for potential customer requirement changes could lead to severe challenges meeting customer's demand. On the other hand, the agile service model can be a significant contributor to a successful outcome. Integration tools and platforms must also support agile service delivery.

"We have developed a service delivery model which enables us to react to changes and not to lock [requirements] down" (Business Area Director)

Comprehensive requirements engineering sub-theme captures one of the most crucial success enablers identified during the research interview. Commonly, business leaders and information technology experts do not fully understand each other. Therefore, it is crucial to ensure that the application and system integration objectives are unambiguous, and all stakeholders must fully understand what the plans and requirements are. The requirement engineering process requires specialized skills to ensure that all potential use-cases are recorded and validated by the end-users. A qualified requirement engineer can significantly increase the likelihood of a successful outcome:

"This is the reason that most of our projects begin with requirements engineering professional who is specialized to gather use cases and requirements from the customer (CTO)

Relevant & usable documents sub-theme captures the full range of technical documentation, system architecture diagrams and models. Relevant & usable documents enable information technology practitioners to get familiar with the system architecture and how systems are integrated. Modern documentation does not mean long and complicated Pdf-documents saved in shared drives, but the documentation should enable a quick overview of the main components, data flows and architecture. The research interviews identified an excellent guideline for integration documents:

"The documentation can also include too many details which can be a problem. It [documentation] should always include abstract to describe all the critical aspects, data sources, data mapping and forks" (Integration Consultant)

There are several modern tools for creating usable and comfortable to use documentations. Too many unnecessary details hinder the usability of the documents.

Security sub-theme captures research findings related to an essential aspect of information security. Application and system integration often enable business-critical functions either internally or externally, and therefore, the data must be secure during transit and in rest.

"We, of course, focus strongly to ensure information security in everything we do [integrations and system development], especially when we work with the data" (Cloud Platform Lead)

4.1.4 Life-cycle perspective

Life cycle perspective theme is divided into future-proofing & scalability and fault tolerance sub-themes presented in table 15. This theme emphasizes the importance of long-term perspective in integration initiatives. It is equally essential that the potential faults and bugs are considered during the implementation phase. The following section describes these two sub-themes in more detail.

Table 15. Life-cycle perspective

Sub-theme	Theme
Future-proofing & scalability	Life-cycle perspective
Fault tolerance	

Future-proofing & scalability captures significant findings highlighting the importance of considering integrations based on their entire lifecycle. Business requirements tend to change over the years, and therefore the integrations should be designed to be scalable and flexible. The scalability and flexibility are important success-factors for both integration service provider and end-users.

"[The system] scalability, it is future-proofing and to ensure that we can also react to the future customer requirements and to be more agile" (Director, Software & Services)

Fault tolerance captures the research data about the potential effects of software bugs or other technical faults in integration. It is recognized by the several research participants that the system must be able to handle potential faults such as problems with the networks. A well-designed integration secure data transfer in every scenario or at least the system must ensure that data is not lost due to malfunction.

"Good transactions to ensure that nothing is lost… fault-tolerant" (Lead Developer)

4.1.5 Platform thinking & utilization

Platform thinking & utilization theme consist of various benefits and success enablers provided by the integration platforms. The thesis research did not focus specifically on any integration platform solution. Therefore, these findings are based on a general perspective regarding both on-premise integration platforms and the cloud-based platforms. The theme included one sub-theme named integration platform utilization according to table 16. The following section describes this sub-theme.

Table 16. Platform thinking & utilization

Sub-theme	Theme
Integration platform utilization	Platform thinking & utilization

Integration platform utilization sub-theme includes research findings related to several different integration platforms as a service. Many research participants mentioned that the well-designed and deployed integration platform could provide measurable business benefits compared to traditional integration methods. Integration platform can offer easy to use, a cost-effective and agile method to integrate multiple systems:

"The idea of a modern integration platform is to enable the cost-effective and agile method to connect several [system] components together" (CTO)

"The integration platform can provide a coherent view of the integrations and more accessible monitoring capabilities. It [the integration platform] can offer significant cost savings "(Business Area Director)

It is also a significant benefit that an integration platform can insulate business-critical systems from user mistakes.

"The integration platform can handle connections for example between ERP and other systems, and it [the integration platform] can protect the business-critical system" (Cloud Platform Lead)

Organizations are transforming their operations by utilizing on-premise and often several different cloud services for maximum positive impact. The integration platform can support this strategy.

"Typical integration platform use-case is multi-cloud scenario… it [the integration platform] can be used to connect these" (CTO)

4.1.6 Tools & solutions

Tools & solutions theme was divided into use of existing libraries, components & solutions and effective & modern tools according to table 17.

Table 17. Tools & solutions

Sub-theme	Theme
Use of existing libraries, components & solutions	Tools & solutions

Use of existing libraries, components & solutions sub-theme gathered findings emphasizing motivations to utilize existing resources and solutions rather than trying to develop everything in-house. It is also common that companies have made substantial investments to information systems and devices. Sometimes existing systems and solutions can be utilized in a new development project, and it can make business sense:

"[About legacy] It would be foolish not to use existing devices and software if these somehow serve the purpose in a new situation and if the customer has already made large investments to a specific environment, tool or product" (Managing Consultant)

Several research participants mentioned that there are a lot of existing software components available to support new integration implementation, and it can save many development resources:

"These days most of the integrations are completed with the help of existing components" (Managing consultant)

Modern cloud-based platforms can also offer specific tools or functions such as machine learning engines:

"For example, if we need a machine learning engine for our [integration platform] application, of course, we utilize existing services [commercial cloud service] rather than trying to develop it by ourselves" (Business area director)

Developing software components requires much effort. Therefore, it is important to utilize existing software libraries, components and tools to maximize development efficiency. However, it is essential to consider also potential licenses.

"Typically, we do not start developing it [required tool or component] if we can find reasonable functionalities from somewhere else [than developing in-house] and it makes sense economically and also licenses and [software] ecosystem seems ok" (CTO)

4.2 Integration obstacles

The integration obstacles share many similar features turned opposite compared to integration success enablers. People, process and technology groups all have overlapping contributions to the identified problems. People and process groups include most integration

obstacle findings perceived by the research participants. Figure 7 presents the identified integration obstacle groups.

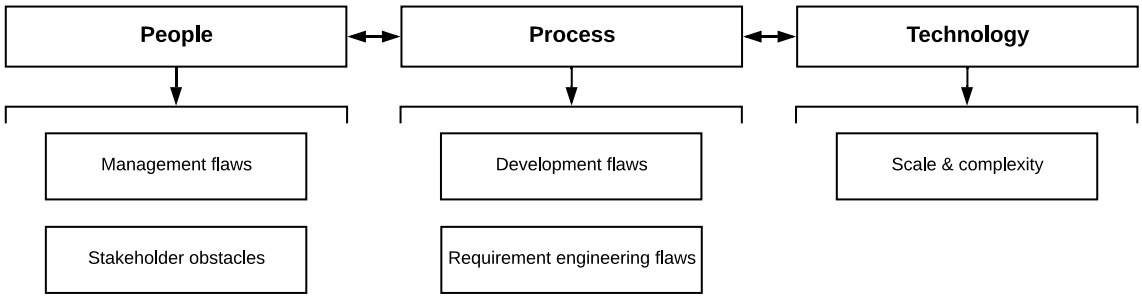

Figure 7. Obstacle groups

It was recognized that by several research participants that the technology itself seldom is a root-cause of the problems, but the complexity of business information systems coupled with the continuously changing business requirements can cause severe obstacles during integration development projects:

> *"I think that typically the larger challenge in this [technology projects] and integrations is not a technology itself but the processes, use cases, requirements, custom requirements to customer's systems […] data and use cases are so different and which then can lead to challenges" (Director of software & services)*

The following sections provide interview extracts from each sub-theme and brief explanations.

4.2.1 Management flaws

Management flaws theme captures research data about the impact of management-related problems and poor practices. It can be argued that the management sets the foundation for successful integration initiatives as well as poor management practices can increase the risk of failure. Large integration development projects were identified as resource-intensive and challenging initiatives. Therefore, organization's management must understand the requirements, motivations to build integrations, and they must also allocate enough resources to the project. Company culture and organization structure should also be considered as one

of the potential obstacles during technology initiatives. Unclear decision-making policy can hinder any development projects.

> *"in our company, there are lots of decision-makers. Furthermore, there is not a single person who says okay, you should do that." (Consultant)*

Management flaws theme was further divided into three sub-themes according to table 18, aiming to capture perceived critical issues identified during the research interviews. These sub-themes are unclear objectives & agreements, unrealistic expectations and lack of holistic perspective. Following sections describe these sub-themes in detail, including text extracts from the interview transcripts.

Table 18. Management flaws

Sub-theme	**Theme**
Unclear objectives & agreements	Management flaws
Unrealistic expectations	
Lack of holistic perspective	

Unclear objectives and agreements sub-theme combines several identified issues related to integration projects and other similar technology initiatives. Several interview participants mentioned during research interviews that contracts are often ambiguous and prepared by the group of people who do not fully understand the technical aspects of the projects. One research participant concluded this potential problem by stating:

> *"The contract context [in integration & technology initiatives] is a major risk since it is common that the [the contract] parties do not know how to make an agreement enabling technical, financial and political success. The context [of contract] and background is not clear. It could be almost 95% risk factor" (Lead Enterprise Architect)*

The integrations often involve complex technical aspects, and therefore the company management does not need to know all the technical details. However, it is rather preferred that technical experts are involved in every phase of the projects. The management should

focus on leading company strategy, to ensure optimal resource utilization, to enable innovation and to ensure that potential integration initiatives can lead to technical, financial and political success.

The unclear objectives and agreements sub-theme also include findings related to verbal agreements between stakeholders. It was recognized that terminology is often ambiguous, and the same term can even have multiple meanings depending on the organization. The ambiguity can lead to severe mistakes during the requirements engineering phase. It was recommended during the research interview that all stakeholders should ensure that they have common terminology, and everyone shares the same vision.

> *"The integrations [initiatives] always involve people from multiple organizations, and it is important to remember that the same [technology & integration] term can mean something else in different organization. Always, ensure that you have understood [the requirements] correctly and what are the objectives" (CTO*

It is vital to set a measure of success in any project related work. The management is responsible for setting key performance indicators and other measures to validate the outcome of integration projects. Integration development projects should be based on actual business need, and the successful project should offer measurable benefits. However, success is complicated to identify, especially without the agreed measure of success:

> *"It is prevalent that [the companies] they do not set a measure of success, why we are doing this [integration initiatives] and what are the desired business benefits" (CTO)*

A fundamental business-related ambiguity was identified during the interviews. A research participant even claimed the following:

> *"I have often vocalized my concern that one of the primary causes of failure in the [IT] industry projects are that only a few people know how to agree on the objectives of a business transaction. This should be a foundation of all business transactions.*

It includes [the contract] price and everything else but the what is included to the contract is left ambiguous" (Lead Enterprise Architect)

Ambiguous contracts and agreements can be a significant problem for all stakeholders. Integration project often involves many cross-functional stakeholders, and it can be argued that unclear agreements are a significant contributor to the difficulties to meet set objectives. At a minimum, miscommunication can cause delays to the deployment:

"There is often a risk that [contract] parties forget what was agreed If the contract about integrations is not formalized. This can lead to misinterpretations and time losses" (Lead Enterprise Architect)

Unrealistic expectations sub-theme captures perceived problems recognized especially within management. Sometimes stakeholders do not have realistic expectations regarding integration projects and other technology development initiatives:

"It is tough to present it [alternative technology & integration ideas] to anyone if the management has already concluded that this is [the project] is easy, cheap and fast" (Management Consultant)

The integration development projects are not a daily occurrence in most of the organizations, and therefore many stakeholders may have minimal knowledge regarding them. The lack of realistic perspective can lead to significant problems such as budgeting failures, schedule planning ambiguities or even total failure of the projects. It is also possible that unrealistic expectations and lack of holistic perspective can contribute to the mismatch between development practices and contractual agreements:

"For example, it is quite a wild idea to plan [technology & integration initiatives] schedules sprint by sprint [Agile] without long term planning if the contract is based on fixed terms and conditions including contractual penalties" (Lead Enterprise Architect)

Simple and small-scale integration deployment projects can lead customers to think that all integrations are quick and straightforward:

> *"The customers often assume that the integrations work just by the click of the button" (CEO)*

Therefore, it is critical to ensure that each stakeholder has a realistic view of the required project schedule, budget, required resources and a realistic expectation of value created by the integrations.

Lack of holistic perspective highlights the importance that management consider integrations regarding long term business strategy. The management must work together with the requirement engineering professional to align business requirements and integration requirements. Integrations often affect the business processes of the entire company. Therefore, development projects must begin with the understanding of the "big picture" and how potential changes affect the business processes:

> *"I would argue that one of the most common causes of failure in software projects and integration initiatives is related to the fact that the companies do not have a person who fully understands the requirements [business & technology]. It is not necessary to know every technical detail but the big picture, what is the business case, what are the desired objectives […] and this is how much we have resources available and then finally how to prioritize goals and objectives" (Director, software & services)*

Technology development projects such as integrations can have a significant positive effect on the company's earning power, but only if the development is based on actual business need and action items are well-planned:

> *"The profit potential [of integration initiatives] is not realized if the company's business development is based on small random actions which do not improve the companies earning capabilities at all" (Lead Enterprise Architect)*

Some research participants even concluded that there is often a serious lack of business development skills in organizations. The lack of business development skills emphasizes the nature of information technology initiatives. The companies should have a holistic perspective on any integration initiative and system development project to ensure a maximum positive outcome:

> *"Based on my experience, unfortunately, it is common that companies deploy integrations based on inadequate information or even false information… Only a few companies systematically lead their business development. The information systems are a component in business operations. However, if the business development is not based on a solid foundation, it then causes the information system development is not based on solid foundation either." (Lead Enterprise Architect)*

Integrations should not be considered as a separate initiative, but the integrations should be rather seen as an enabler to meet broader business objectives. This holistic perspective was also identified several times as integration enabler. The management role is strongly emphasized, ensuring that all development projects are aligned and supports broader strategic objectives.

4.2.2 Stakeholder obstacles

Stakeholder obstacles theme includes a broad range of research findings related to stakeholders. The theme was further divided into six separate sub-themes according to table 19 to separate different aspects identified in the research material. The sub-themes are lack of resources and skills, poor communication, change resistance, conflicting interests, collaboration problems and long-time horizon. It is also recognized that there is a degree of interdependency between these sub-themes. For example, a lack of resources can lead to conflicting interests, and collaboration problems and long-time horizon can cause multiple issues. The following section describes research findings categorized into sub-themes under stakeholder obstacles.

Table 19. Stakeholder obstacles

Sub-theme	Theme
Lack of resources & skills	Stakeholder obstacles
Poor communication	
Change resistance	
Conflicting interests	
Collaboration problems	
Long time horizon	

Lack of resources & skills sub-theme captures the importance of cross-functional skills. One research participant commented that generally, IT-professionals are not perceived to have enough skills enabling direct customer interaction:

> *"I would say that probably IT-experts are not considered as marketing or sales specialists which are important skills when interacting with customer organization" (Integration Consultant)*

It was also a common finding during research interviews that participants mentioned that lack of resources could hinder collaboration among stakeholders:

> *"They [stakeholders] are doing projects too, and they might not have the required resources available to support us, and it can cause problems. Even the small change order can take a long time. Sometimes they [the stakeholders] have told us that the resources are available after several months" (Full-Stack Developer)*

However, it was generally agreed among the research participants that lack of resources and skills is mainly due to overlapping projects, third party dependency and conflicting interests.

Poor communication sub-theme highlights the common problem identified during the research interviews. Most of the integration initiatives involve stakeholders from the different internal or external organizations, and the lack of active and effective communication can hinder otherwise successful project objectives. Several research

participants agreed that lack of active communication is a significant root-cause of project delays, problems or even catastrophic failures. It was recognized that communication problems tend to increase when external stakeholders are involved:

> *"The communication issues between different vendors and stakeholders are top of the list [potential problems] based on my experience. For example, the other vendor cannot produce clear written communication, they do not reply to messages, or they just do not understand what we are talking about" (Software Architect)*

> *"I would say that the root cause of all major problems is communication [lack of it]. The communication is an obstacle every single time if the project involves third parties [internal & external] or we need to build integrations to other systems" (Full-Stack Developer)*

Sometimes bureaucratic organization structures can cause communication problems. It is a common problem that the integration development team has limited access to actual end-users. Therefore, it can increase the risk of miscommunication:

> *"Communication flows through so many different stakeholders, especially in a larger company… We seldom have direct contact with the customer organization [end-users], sometimes the connection is only to the customer's IT people" (Integration Consultant)*

Change resistance sub-theme was identified as a relatively minor problem during research interviews, but it should be still considered during large integration initiatives. Sometimes employees are used to performing daily tasks in a certain way, and any changes can raise change resistance and therefore hinder the potential improvements projects. One research participant provided an excellent example of a typical change resistance scenario when the business process was transformed from a paper-based process to a modern system enabled by real-time application integration:

> *"For example, one of our customers has used paper documents to process [employee] salary data into a payroll system. The modern real-time [application]*

integration was deployed, and it caused significant challenges for employees [to adopt the new system] (CEO)

It can be argued that change resistance can also affect the adoption of modern development methods. It was common research finding that the participants claimed that the development team would like to be more agile. However, then the customer organization project planning is based on the traditional water-fall type of system. This problem is also related to contractual challenges:

"The customers often still follow the water-fall approach in their projects, but we as IT-practitioners would prefer more agile methods. This can sometimes cause little conflicts" (CTO)

Conflicting interests can hinder the progress of initiatives because of integration initiatives can involve many stakeholders, and the development phase can expand even years. These factors can contribute to the problem, and the stakeholders are not only focused on one project but are working with many initiatives at the same time:

"The prioritization [of features & tasks] is often an exhausting task since there are always many competing tasks [internal & external]. They might have their conflicting objectives [other stakeholders], and sometimes these objectives are interdependent. This can cause problems" (Senior Consultant)

It was recognized that the conflicting interests are common, especially in a project involving many external participants. There can also be similar issues in the large company's internal organization. The conflicting interest can also be identified when the project participants would like to capture the benefits of fixed development contracts. However, then they would also prefer using agile development methods:

"Often, they say [customers] that we are agile, but then they require a fixed schedule, exact budget and the project objectives must be reached within these conditions" (Senior Consultant)

It is a common challenge that the business organization and development organization might have different priorities and objectives which can lead to conflicting interests and problems in general. Several research participants claimed that the organization's sales team objectives are related to sales performance and the objectives are not always synchronized with the development team objectives:

> *"The problems often arise when selling party and the implementors are separate groups or when these stakeholders have different objectives" (Senior Consultant)*

Collaboration problems sub-theme is closely related to communication problems. Collaboration challenges were identified as a common problem when the project involves multiple different vendors and other external stakeholders. A research participant even pointed out that the problem is increased when the 3rd party has little financial or other motivation to collaborate with the development initiative.

> *"Somehow, when there are three or more parties [in the project], and our customer does not have direct contact with that 3rd. party […] Commonly, this 3rd party is not that interested in" (Full-Stack Developer)*

It is also essential that the integration development organization builds a mutual trust between the team and the customer to ensure that the potential issues can be resolved quickly. It is equally essential that the development team offering services are honest and has enough courage to disagree with the customer when it is required. One research participant raised a concern that they continuously see the service vendors to over-promise just to get the desired contract. Over-promising can lead to significant problems during the development projects:

> *"There are also cases that the vendor does not have enough courage to say no to their customer. We have seen many vendors who promise anything to the customer. [just to get a deal]. Sometimes it would be recommended to slow down and also seek alternatives [technical solutions]" (CTO)*

Integration initiatives involving especially multiple external stakeholders require agile project methods. It is a common problem that one stakeholder can hinder the project

objectives and schedules of all other stakeholders. Several research participants recommend that integration initiatives should not be based on traditional project planning since there are always unknown factors in a complex system:

> *"Many project participants [in a multi-vendor project] certainly fail to keep their promises and schedules, and it would be foolish trying to fix these [our plans] since there are so many variables" (Business Area Director)*

Long time horizon sub-theme captures typical challenges, especially in a large and complex system development scenario. Many large information systems are utilized up to10-15 years after the initial deployment, and therefore the long-time span can cause multiple problems. The long-time horizon makes integration cost calculations difficult. It was recognized during research interviews that the total cost of software and integration is not clear for many customers:

> *"One of the common challenges in integrations and other technology initiatives is that the participants do not fully understand the total cost of ownership [the system or device] (Director, software and services)*

The long-time span can also cause many other issues other than financial budgeting. Complex systems and application integration scenarios require a comprehensive understanding of the company's business processes and architecture. The expert employees might resign from the company. Therefore, it is critical to ensure that the systems and integrations are well-documented, and knowledge is always shared among several participants:

> *"It is a significant challenge to agree roles, responsibilities, communication and ensure that all stakeholders understand them because of projects [technology & integration projects] often re-occur only after 10-15 years. The involved employees might have left the company, and so on. In our industry, these projects are not part of daily routines but rather an exception (Director, software & services)*

4.2.3 Development flaws

The development flaws theme was further divided into three separate sub-themes. These sub-themes were set as integration spaghetti, poor documentation and technical debt according to table 20. There is an inevitable overlap between sub-themes which highlights the complexity and interdependency of integration initiatives. The following section analyzes each of these sub-themes in detail, including text extracts from the interview transcripts.

Table 20. Development flaws

Sub-theme	**Theme**
Integration spaghetti	Development flaws
Poor documentation	
Technical debt	

Integration spaghetti sub-theme was used to collect research findings related to a common problem in larger information systems. Some organization have not succeeded to plan their application and system integration holistically, and many point-to-point integrations were developed over the years to meet changing business requirements. Point-to-point integrations between different applications can finally lead to the chaos, which is often called an integration spaghetti. A large enterprise can have hundreds of different applications and systems, and it can lead to significant development problems in the future if these systems were integrated without long term perspective and holistic business planning:

> *"We have seen cases [integration projects] where a web of integration spaghetti consists of 500-600 systems." (Business Area Director)*

Application integrations often involve business-critical functions. Therefore, it is a significant challenge to change the entire architecture while ensuring the company's business performance. Most of the research participants recognized that the integration spaghetti could lead to unmanageable development problems. If one system is updated, it can have disastrous consequences affecting the entire business operation:

"The spaghetti-integration is an absolute no-no" (Business Area Director)

Strong interdependences between software systems and components are generally considered a poor software engineering practice:

> *"The tight point-to-point integrations cause strong interdependences between systems, and if one system is down, the other is not available either" (Cloud Lead)*

Many organizations initially developed tight point-to-point integrations between their systems but then realized the problems this method can cause in the future.

> *"There were many point-to-point integrations in the past, but then it was understood that it creates an integration spaghetti, and if one system requires changes, the other one must be changed too. Finally, this design leads to unmanageable chaos (Managing Consultant)*

Poor documentation sub-theme includes common research findings related to lack of communication or lack of usable and relevant documentation. Integrations involve complex enterprise systems, and therefore the comprehensive, updated, accurate and relevant documentation is critical for future development initiatives or to troubleshoot potential faults. It was common research finding during interviews that the research participants reported inaccuracies in the available documentation. Inaccuracies can lead to development mistakes or project delays:

> *"You should not trust too much on documentation [accuracy of it]" (Software Architect)*

Maintaining documentation up to date was identified as one common issue. Participants reported several cases when changes into application interfaces were not recorded into documentations, and these undocumented system customizations can lead to significant problems later:

> *"Commonly, the existing documentation about interfaces is not up-to-date because of these [the interfaces] are not maintained so well." (Software Architect)*

It can be risky to rely upon only documents and specifications given by third party:

> *"We have often tripped to the same problem that we did not verify interfaces and other components in advance, and then during integration implementation, we realize that the API specification does not represent actual data output of the interface." (Software Architect)*

This research finding also highlights the importance of testing and prototyping to ensure the validity of interface specifications. Many organizations update their documentation processes, but the old documents do not always get the appropriate attention, and there is a risk that the new documentation system does not include all older versions:

> *"For example, sometimes minimal resources are used to transfer old Word-based integration documents stored in a server to the new cloud-hosted Confluence system" (Integration Consultant)*

Several research participants commented that it is not enough that the documentation is comprehensive, but it must be usable too. Too complicated documentation can lead to difficulties to utilize it. A research participant commented that the interface documentation of the one popular service is relatively difficult to understand especially without comprehensive knowledge about the specific field:

> *"[a major Finnish public organization] is a good example that the interfaces are well-documented, but it is challenging to understand if you are not an insider [in the specific field]" (CTO)*

It is recommended that the technical documentations enable anybody to follow them without comprehensive domain knowledge.

Technical debt sub-theme captures research findings regarding shortcuts and ignoring best practices and standards. Commonly, integration development initiatives involve tight schedules and budgets, which can potentially lead to poor development decisions:

"Sometimes when we have to deploy something [technology & integrations] quickly, we just have to take some short cuts, and then we return to these later if needed" (Senior Consultant)

Shortcuts can finally lead to significant technical debt. It was mentioned earlier that integrations often enable business-critical functions. Therefore, it is not easy to make changes to major components without interrupting business operations. Technical debt sub-theme also captures short term perspective that testing is not always necessary:

"Many companies do not even have proper test environments, which I think is a major concern" (Full-Stack Developer)

Lack of comprehensive testing can lead to costly failures in the future, and there testing should never be ignored. Custom configurations are often necessary, but all these should be well-documented to avoid problems:

"Sometimes we have identified business-critical integration implementations which do not follow vendor's official documentation due to custom configurations" (CEO)

Undocumented custom modifications can have significant adverse effects throughout the lifecycle of the system. Some companies must struggle with the outdated legacy systems because of the risk of updating unknown functions is too big:

"Sometimes our customers report a problem, but then the actual root-cause is some other vendor who has implemented some quick and dirty solution by the request of the customer…It has caused a situation that the organization must use the old legacy software version because people are afraid of updating the system. Nobody knows what happens if the system is updated" (Managing Consultant)

Poor development practices can lead also ignoring necessary standards relating processes and data formats:

"Recently, we have had few problems with a large customer's systems because of the integration data flow included some messages which did not meet their internal specifications [customer's own internal problem]. The incorrect standard led to a fault in an integration platform when the system tried to map it to the preferred format. These situations require often difficult negotiations who is responsible, and who should pay the cost" (Integration Consultant)

4.2.4 Requirement engineering flaws

Requirement engineering flaws captures frequent issues identified during integration projects. Table 21 presents this theme and two sub-themes.

Table 21. Requirement engineering flaws

Sub-theme	Theme
Unclear requirements	Requirement engineering flaws
Requirement changes	

Unclear requirements sub-theme was seen as a significant obstacle in several research interviews. In contrast, the comprehensive and unambiguous requirements were important success enabler too.

"Commonly, it is not clearly stated what are the objectives and why we are actually doing this [the integrations]" (CTO)

The developers might waste lot of resources to build unnecessary features and functions if requirements are not explicitly stated

" If requirements are ambiguous, we [developers] might build something else than what customer ordered" (Developer)

Requirement changes sub-theme is related to unclear requirements. It was discussed several times during interviews that changing requirements can cause major problems for all stakeholders.

” The specification is not clear, and the requirements are not fixed” (CTO)

It is not enough that requirements are clear but at least significant objectives should be fixed to avoid major losses.

” It’s quite common that a customer has vision [about service integration or new service] but then finally when they see the actual service, they do not like it anymore” (Full-Stack-Developer)

Customers sometimes have different vision regarding final product or service.

4.2.5 Scale & Complexity

Scale & complexity theme includes significantly fewer research findings compared to people and process-related themes. The theme was further divided into two sub-themes which were set as large scale and legacy & multiple overlapping systems according to table 22.

Table 22. Scale & complexity

Sub-theme	**Theme**
Large-scale	Scale & complexity
Legacy & overlapping systems	

Following sections describe these two sub-themes in more detail.

A large-scale system always involves more complex integration scenarios as well. The process requires significant resources from all the stakeholders and decision-makers. Many established organizations have developed their enterprise systems over the long period, and therefore these information systems often include a complex mix of legacy systems and several modern systems. However, the transformation from the legacy system to the modern system requires significant financial resources, skills and comprehensive planning. The reason why many companies still operate both legacy, and modern systems were concluded in this research interview comment:

"Even though [organization's] financial resources would be unlimited… then the obstacles are lack of skills, complexity, availability of resources, management of all this while mitigating the risks. This is the reason that many organizations must run two trains at the same time for years [both legacy & modern systems]" (Lead Enterprise Architect)

An extensive application and system integration initiative require significant resources already in the critical planning and requirements engineering phase. Commonly, the integration development team or the integrator organization must meet extensive requirements to be qualified into the final project phase. A research participant described resource-intensive planning and prototyping phase:

"We had a project with eight vendors, and we asked them to reply to hundreds of questions [regarding service delivery], then they all organized a demonstration for us, then top-3 was selected and finally these included proof of concept. I mean, it is a very long and tedious process." (Managing Consultant)

ERP related integrations were perceived as one of the most challenging cases among interview participants:

"It is [large integration project] a very resource-intensive process, for example, if we think a large organization with 40 ERP systems and these should be integrated to some other system… It is just very time consuming and difficult since technically, each ERP should be handled as a separate integration case." (Cloud Lead)

"It is a quite massive system [a large Finnish service platform], and we did more than a year only the requirement engineering phase" (Key Account Manager)

Sometimes information systems development begins with the simple product or service but changing business requirements might require continuous changes which then increase the complexity and total cost of the initiative:

"These largest projects [integration & system development] can last for years, and it is common than the project is relatively small at the beginning, but then the project can finally become huge due to continuous development [required system changes]" (Full-Stack Developer)

The legacy & overlapping systems could have been deployed for several years or even decades ago, and business requirements could have been significantly different at the time. Main-frame systems were not intended to communicate with other systems, and therefore integrating these legacy systems can be a significant challenge:

"There is still a main-frame type of systems which were never designed to be integrated with other systems. The system might not have interfaces at all" (Cloud Lead)

Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT) is a well-known data transfer standard utilized by many global companies. The companies are slowly transferring to other standards, but there is still a significant need to use EDIFACT:

"The companies still use a lot of EDIFACT to transfer the data or other similar more legacy technology" (Integration Consultant)

5 DISCUSSION

This chapter discusses the thesis research findings and reflections from the perspective of the author. The chapter reviews briefly the motivations and research questions, then explains the significant findings and the chapter also relates these findings to the literature review. The chapter continues with the considerations of potential research limitations and weaknesses. The chapter is concluded with the suggestions for future research within this area.

The thesis research objective was to understand what factors are affecting application integrations according to Finnish software industry practitioners. The research problem was divided into two separate perspectives. These perspectives were stated as a form of two research questions.

> *RQ1: What are the enablers of successful application integration from the perspective of the selected Finnish software industry practitioners?*
>
> *RQ2: What are potential integration obstacles recognized by Finnish software industry practitioners?*

Two separate research questions enabled a broad perspective to the multifaceted real-life software engineering challenges often identified in the integration initiatives. It was deemed beneficial to view the phenomenon from the two-opposing perspective since research participants perceived enablers and obstacles based on their individual industry experiences. This allowed the research participants to elaborate on their experiences from a broad perspective, which was beneficial for the overall outcome of the research. The research data collection was conducted as 20 semi-structured interviews with the Finnish software industry practitioners during February and March 2020. The collected data was analyzed following thematic analysis principles. The broad range of interviewees professional roles enabled necessary considerations from both management and from the developer point of view.

The research findings related to integration enablers were grouped to people, process, and technology to separate different findings under simple groups. These groups included six

associated themes and 20 separate sub-themes in total. It was necessary to combine multiple themes and sub-themes to keep results manageable. The research identified that the people group includes a considerable number of positive factors affecting successful integration initiatives. The research also confirmed that all three enabler groups are interdependent and therefore, success is not based on individual enablers but rather a combination of multiple factors. Goedeke et al. (2017) confirm that factors are interdependent.

Several research participants agreed that management has a vital role in aligning integration objectives with the company's long-term business strategy. The management also allocates resources to implement integrations and enable effective communication between cross-functional stakeholders. It is equally essential that the management understand the potential business benefits created by the integrations, but it is essential to recognize the potential drawbacks too. Therefore, the author claims that the management's most important role regarding integration initiatives is to ensure available resources, align objectives with the broader company strategy and offer support to necessary operational functions. Integrations also require comprehensive technical knowledge which is the reason that management must consult the organization's technical experts and trust their expertise. External integration professionals should be utilized as deemed necessary.

The development best practices theme was also strongly represented within the research data. The application integrations are often part of the larger system development initiative, and therefore general software engineering best practices are applicable. Most of the research participants emphasized the importance of comprehensive requirement engineering practices. It is essential to understand why integrations are implemented, what are the business processes, integration objectives and how current systems and infrastructure is built. The integration initiatives often expand for an extended period of times, and therefore the development team must be ready to adjust objectives according to changing business requirements. This highlights the importance of agility in both development practices and in the implementing organization.

Modern integration tools are generally mature and perform well in different scenarios. However, the market is filled with integration tools and platforms, and therefore enough resources must be used to select an appropriate tool for the specific use-case and

environment. The research participants recommend utilizing existing tools and libraries rather than spending resources to develop them in the house. Utilization of external tools and platforms decrease the organization's control over the system and potentially creates strong third-party dependencies. However, this approach frees resources to other development tasks and therefore it is advisable.

The research findings related to integration obstacles were grouped to people, process and technology to follow the same structure than in the success enablers category. The findings related to integration obstacles were first divided into five separate themes, and the themes were further divided into 16 associated sub-themes to capture broad findings. The integration obstacles share the feature with the integration enablers that themes are interconnected, and problems are not caused only by the one theme but rather a combination of the several factors. The people group of factors is strongly represented also in the integration obstacles. Management's lack of holistic perspective and lack of understanding the technical aspects were often seen as significant obstacles. Most research participants mentioned that internal and external communication issues frequently occur in the integration initiatives, and the author claims that it can be a significant contributor to several other obstacles too. Poor communication can lead to misunderstandings, unrealistic expectations and ambiguous agreements. The integration initiatives involve business-critical processes in organizations, and therefore the miscommunication can lead to significant financial losses and customer dissatisfaction.

The research findings related to poor development practices were also recognized during most of the interviews. One frequent anti-pattern was identified as point-to-point-integrations or so-called spaghetti integrations. It was mentioned by the several research participants that the spaghetti integrations can cause significant obstacles to maintain and further develop system integrations.

The lack of comprehensive and explicit integration requirements was often identified as a significant cause of problems. The requirement documents and other agreements are often left ambiguous, and it is difficult for developers to meet the requirements. This can lead to delays, budget overruns and inefficient implementation. It is also recognized that the large organization's information systems are massive in scale and the large-scale increases

complexity. Many organizations must manage both legacy systems and modern systems at the same time for years since the transformation often require enormous resources.

5.1 Comparison to literature

The industry practitioners interviewed during the thesis research share similar views about integration success enablers compared to literature findings discussed in chapter 2. Gericke et al. (2010) identified seven success factors and most of them were discussed during research interviews as well. Especially the importance of aligning IT / business strategy, ensuring active collaboration between cross-functional teams, architecture management and standardized tools and methods were agreed as critical. However, according to Gericke et al. (2010), IT/Business Alignment factor is not as important as often emphasized in the thesis research interviews. Lam (2005) added top management support and understanding as a critical success factor. It was also concluded during the thesis research that the management role is vital during integration initiatives ensuring enough available resources, enforcing best practices and enabling effective communication. The research participants also share the same views with the Lam (2005) regarding the importance of comprehensive project planning and execution.

Several interview participants mentioned that integrations are often part of the larger system development project. Therefore, IS-project failure groups identified by Goedeke et al. (2017) in the chapter 2 were recognized during thesis interviews as well. Goedeke et al. (2017) listed 13 IS-project failure groups such as failures regarding project scope, planning, requirements and failures related general project management. These were all recognized as obstacles by the thesis research participants affecting integration initiatives as well. Goedeke et al. (2017) also list problems such as lack of communication between stakeholders and ambiguous contracts. The thesis research participants emphasized lack of communication and ambiguous requirements as significant obstacles in the integration initiatives too. Therefore, it can be argued that integration initiatives share similar obstacles than other IS-projects.

Themistocleous (2004) identified 12 application integration barriers discussed in chapter 2, and especially high cost, system complexity, lack of technical skills and confusion in the integration marketplace were emphasized. The Finnish industry practitioners shared the same perceptions that the system complexity and high cost of the new initiatives can be significant obstacles. However, lack of technical skills was not strongly emphasized even though it was mentioned that new talents are not always easy to hire. The Finnish industry practitioners did not raise significant concerns about integration tools.

5.2 Limitations

The thesis research includes several limitations. Firstly, qualitative research method utilized in the research consists of a few limitations. The research findings do not enable generalizations to other Finnish or international software companies. The results are based on the perception of a narrow group of individual Finnish software industry practitioners. Secondly, the results were derived from the first interview round of SASSE research project and the interview questions were designed to gather broad experiences from the Finnish software development companies. The broad interview structure was an excellent choice for the overall SASSE research objectives, but this broad approach limited the thesis related questions. Thirdly, the research included confusing terminology such as external services and the term integrations itself is ambiguous. The confusing terminology can lead to misunderstanding of questions and therefore contribute to the result misinterpretations. However, the identified conflicting results were omitted. Fourthly, the thesis research project is strictly time-bound, and it was necessary to limit the research scope and analysis to meet the agreed schedule.

Despite of a few limitations, the author claims that research provided valuable insights and useful research data for the following research phases of SASSE.

5.3 Suggestions for future research

Integration scenarios, processes and methods are complex and broad concept. Therefore, it is not possible to cover all aspects in the one limited thesis research. The research findings introduced in the chapter 4.2 reveal that many integration obstacles still frequently occur in the integration initiatives implemented by the Finnish companies. These findings indicate

that further research is necessary and therefore the following potential research questions are suggested.

Q1: *Why similar integration obstacles seem to persist over the year's despite of available research findings?*

The comparison of obstacles in the chapter 2 and the obstacles recognized by the Finnish industry practitioners in chapter 4.2, confirms that many obstacles in integration initiatives and in IS-projects in general seem to persist over the years. Further studies could aim to find why these problems persist.

Q2: *Is there any difference between integration enablers and obstacles between internal integrations compared to integrations to external services controlled by a third party?*

This thesis studied integration enablers and obstacles in general and therefore it could be beneficial to recognize the potential differences between internal integrations and external integrations.

Q3: *What are the integration success enablers and obstacles from the perspective of customer organization or from the perspective of other stakeholders?*

The thesis research perspective included companies implementing integrations and other software consulting services. It is possible that other stakeholder's views are different.

Q4: *What enables organizations to transform their integration development processes toward more agile integration methods while maintaining contractual commitments?*

It was recognized in the chapter 4 that contractual commitments often guide organizations toward fixed integration objectives. However, the continuously evolving business environment requires development methods which can easily accommodate changes during the initiatives.

6 CONCLUSION

This research aimed to identify integration success enablers and obstacles according to Finnish software industry practitioners. Based on the 20 semi-structured interviews conducted by the SASSE research team, it can be concluded that there are significant number of success enablers and frequent obstacles in Finnish integration initiatives. The research data was analyzed following principles of thematic analysis. The results presented in chapter 4 indicate that many obstacles persist over the years and these obstacles can seriously hinder organization's integration objectives. However, the organizations can increase the likelihood of successful outcome by ensuring that success enablers are considered in every phase of the integration initiatives.

The two research questions introduced in chapter 1, guided the data collection and analysis process and the results provide answers for both research question. Therefore, the research objectives agreed at the beginning of the research project have been met. All research findings were organized into three distinctive groups emphasizing the interplay between different factors in the application integration scenarios. These groups were named as people, process and technology. The integration success enablers category was further divided into six themes and several sub-themes according to a table in appendix 1. The integration obstacles category was divided into five separate themes and several sub-themes according to a table in appendix 2.

Application integration initiatives require cross-functional collaboration between all stakeholders, effective teamwork, technical development skills and business process skills, appropriate tools and effective management practices. The research confirms that integrations are inseparable part of modern enterprise systems, but the integration development initiatives are often filled with the obstacles. Due diligence, learning from the past experiences, continuous development and organization agility increases the likelihood of successful outcome.

The thesis research contributed to the first phase of SASSE research project. The results confirmed literature findings and offered valuable insights about multifaceted integration initiatives conducted in Finnish software companies.

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APPENDIX 1. Integration success enablers

Governance & management competencies Project management SMART goal setting Value focus	Management	**People**
Technical & cross-domain skills Active collaboration Mutually beneficial relationships Active communication	Stakeholders	
Loose coupling & high cohesion Follow & encourage standards Testing & prototyping Simplicity & usability Agility Comprehensive requirements engineering Relevant & usable documents Security	Development best practices	**Process**
Future proofing & scalability Fault tolerance	Life-cycle perspective	
Integration platform utilization	Platform thinking & utilization	**Technology**
Use of existing libraries, components & solutions	Tools & solutions	

APPENDIX 2. Integration obstacles

Unclear objectives & agreements Unrealistic expectations Lack of holistic perspective	Management flaws	**People**
Lack of resources & skills Poor communication Change resistance Conflicting interests Collaboration problems Long time horizon	Stakeholder obstacles	
Integration spaghetti Poor documentation Technical debt	Development flaws	**Process**
Unclear requirements Requirement changes	Requirement engineering flaws	
Large scale Legacy / multiple overlapping systems	Scale & complexity	**Technology**