



**DIGITALIZATION THROUGH INTEGRATION IN SMES: PROCESS  
DEVELOPMENT IN RESOURCE-LIMITED ENVIRONMENTS**

Lappeenranta–Lahti University of Technology LUT

Master's Programme in Software Engineering and Digital Transformation

2022

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## ABSTRACT

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### **Digitalization through integration in SMEs: Process development in resource-limited environments**

Master's thesis

2022

45 pages, 6 figures and 2 tables

Examiners: Professor Jari Porras and Associate Professor Ari Happonen

Keywords: SME, system integration, integration implementation

Integration of information systems can provide significant benefits for the organizations being able to successfully achieve it. In the environment of increasing competition caused by the constantly globalising world, integration has become a requirement for long-term survival of businesses. This especially applies to SMEs, which must compete against larger companies having the advantages of scale by their sides.

The purpose of this thesis is to investigate the options, possibilities, and challenges SMEs have in implementing integration with limited resources. A literature review was conducted to study the theoretical background and the previously used approaches. An integration implementation was then carried out in the case company. Based on the research, SMEs do have integration needs but they are rarely perceived critical. Integration with limited resources is possible to a certain extent, although the availability of APIs was concluded to be restricted.

## TIIVISTELMÄ

Lappeenrannan–Lahden teknillinen yliopisto LUT

LUT Teknis-luonnontieteellinen

Tietotekniikka

Juho Hupanen

### **Digitalisaatio integraation avulla PK-yrityksissä: Prosessinkehittäminen resurssirajoitteisissa ympäristöissä**

Tietotekniikan diplomityö

45 sivua, 6 kuvaa ja 2 taulukkoa

Tarkastajat: Professori Jari Porras ja Apulaisprofessori Ari Happonen

Avainsanat: PK-yritys, järjestelmäintegraatio, integraation toteutus

Tietojärjestelmien integraatio voi tarjota merkittäviä hyötyjä niille organisaatioille, jotka onnistuvat sen toteutuksessa. Integraatiosta on tullut edellytys yritysten pitkäaikaiselle selviytymiselle alati globalisoituvan maailman aikaansaamassa kiristyvän kilpailun ympäristössä. Tämä pätee erityisesti PK-yrityksiin, joiden on kilpailtava mittakaavaedusta hyötyvien suurempien yhtiöiden kanssa.

Tämän työn tarkoituksena on tutkia, mitä vaihtoehtoja, mahdollisuuksia ja haasteita PK-yrityksillä on integraation toteuttamisessa rajallisilla resursseilla. Teoreettisen taustan ja aiemmin käytettyjen lähestymistapojen tutkimiseksi suoritettiin kirjallisuuskatsaus. Tämän lisäksi tehtiin integraation toteutus esimerkkiyrityksessä. Tutkimuksen perusteella voidaan todeta, että vaikka PK-yrityksillä on integraatiotarpeita, ne mielletään harvoin kriittisiksi. Integraatio rajallisilla resursseilla on mahdollista tiettyynajaan asti, joskin ohjelmointirajapintojen saatavuus todettiin olevan rajoitettu.

## ACKNOWLEDGEMENTS

I would first like to thank the supervisor of this thesis, Associate Professor Ari Happonen, for providing invaluable guidance and feedback. I would also like to express my gratitude to the people from the case company who offered me this exciting challenge and learning opportunity. Finally, I would like to thank my family for supporting me through all these years.

*Juho Hupanen*

20.2.2022

## ABBREVIATIONS

API	Application Programming Interface
ASP	Application Service Provider
B2B	Business-to-Business
B2Bi	Business-to-Business Integration
CRM	Customer Relationship Management
CSV	Comma-Separated Values
EAI	Enterprise Application Integration
ERP	Enterprise Resource Planning
ESB	Enterprise Service Bus
iPaaS	Integration Platform as a Service
IS	Information System
JSON	JavaScript Object Notation
MSA	Microservice Architecture
REST	Representational State Transfer
RPA	Robotic Process Automation
SaaS	Software as a Service
SCM	Supply Chain Management
SME	Small and Medium-sized Enterprises
SOA	Service-Oriented Architecture

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Abstract

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# 1 Introduction

Digitalization and digital transformation are revolutionizing the way companies do business. With the dawn of Industry 4.0 already being upon us, innovations such as the Internet of things (IoT) and a rapidly growing number of smart devices are generating more and more data every day for various kinds of systems and applications to process. Enterprises of all sizes must be able to adapt to the changing environment by tapping extended fleets and networks (Kinnunen et al., 2019), implementing new technologies and gainsharing models (Happonen & Siljander, 2020) to stay competitive and to be able to adopt new business models (Eskelinen et al., 2017) in increasingly global markets. In many cases, that has led to the gradual introduction of multiple complex information systems which may not be interconnected or interoperable (Bayrak, 2013). Integrating these systems can bring challenges especially to small and medium-sized enterprises (SMEs) which tend to be relatively resource-limited and therefore do not have all the options the large businesses have at their disposal (Bouwman et al., 2019). For example, large companies can make significant savings by slightly lowering their variable costs that could cover the entire cost of an information system a small company could barely afford. This appears to be an important problem for SMEs as digitalization has proven to be a key factor driving their financial performance (Eller et al., 2020). In this thesis, the possibilities and challenges of integration are studied from the viewpoint of SMEs. A literature review is conducted, based on which an implementation of an integration solution is performed in a case company.

## 1.1 Background

According to the Pareto principle, 20 percent of causes account for 80 percent of consequences. Although the principle was originally used in the context of wealth distribution, it can also be applied to organizational decision making. (Craft & Leake, 2002.) An SME may be, for example, able to get 80 percent of the benefits of an information system project by allocating the resources on development of the features falling in the most valuable 20th percentile. Therefore, the role of resource decision making remains essential especially for SMEs that must fight for their existence in competition against companies of both the same and larger size.



To achieve success in integration of enterprise systems and applications, SMEs must choose an integration model that suits their business needs with limited costs. The emergence of cloud computing during the last couple of decades has enabled companies to move their information systems beyond the organizational boundaries. The pay-per-use model has helped SMEs to lower their costs by eliminating the expenses related to on-premise systems. (Kleeberg et al., 2014.) One option leveraging cloud technology is to outsource the internal applications to an Application Service Provider (ASP) which can provide a centralized service connecting the applications through one access point. This is also known as Software as a Service (SaaS). The favourable factors of the ASP model include increased flexibility, ease of use, and more efficient information processing, while potential downsides consist of dependability on the provider, and issues with security and upgrades. (Bayrak, 2013.) However, system integration is a broad concept, and the aforementioned model is just one of the numerous architectural decisions one can make regarding implementation of integration. In real world, companies tend to combine different approaches according to their needs (Bidan et al., 2012).

## 1.2 Goals and delimitations

The goal of this thesis is to study digitalisation through integration of information systems and business processes from the SME point of view. To be more precise, the aim is to figure out the possibilities and challenges that SMEs have in integration. A literature review is conducted to get an overview of relevant topics. The findings from the review are assessed by analysing how the focus of the literature is distributed among different areas. A case study in an SME is then carried out involving a development of an integration tool. Furthermore, the case study attempts to find out how well the findings from the literature apply to the environment of an internationalising Finnish SME and what are the views of the people working in the industry on the possibilities and challenges of integration. The scope of this research is limited to small and smaller medium-sized enterprises as businesses larger than that are not financially limited in the same way as their smaller counterparts. The research questions this thesis seeks to answer are:

RQ1: What are the possibilities and challenges of software integration in SMEs with limited resources?

RQ2: How can a business process be improved through integration in the case SME?

The first part of the thesis, the literature review, aims to find answers to the research questions by exploring both the managerial and technical perspectives on integration. The division into these categories has been done according to the author's observations on clear pattern of distribution in the source material. Also, similar kinds of categorizations have previously been used in the literature, as mentioned in subchapter 2.4. The empirical part of the thesis is used to further answer the research questions from the viewpoint of practical implementation.

### 1.3 Structure of the thesis

The thesis is divided into seven chapters. This chapter provides an introduction to the background of the thesis and presents the goals and limitations of the research. In the second chapter, the conducted literature review is described and its results are analysed. The third chapter focuses on the organizational themes identified in the literature review, while the fourth chapter addresses the technical concepts. In the fifth chapter, the case company is introduced after which the integration problem and proposed solution are presented. The sixth chapter includes discussion about the findings of the research. The seventh and final chapter summarizes the thesis and provides a conclusion of the found results.

## 2 Literature review

In this chapter, the phases of the literature review process are described. Additionally, the findings of the review are classified and analysed. The purpose of the conducted literature review is to provide an overview of integration from the viewpoint of SMEs. The findings are utilized in the next two chapter to further build the theoretical basis of the thesis.

### 2.1 Search process

Google Scholar was used as the initial search engine for finding applicable articles. Additionally, academic databases, such as IEEE Xplore, ACM and ScienceDirect, were utilized to ensure the completeness of the material. The search terms were mainly applied so that keyword “SME” was combined with keywords “integration”, “system integration”, “application integration”, “data integration”, “integration platform”, “approach”, and “case study” among others. Additionally, the types of related systems and applications in the case company were further used as keywords by combining them with the aforementioned search terms. The titles and abstracts of the search results were skimmed through, and the suitable publications were included in the review. The inclusion requirement for the articles was that they had to include topics related to the thesis case. Finally, 35 articles were included in the review.

During the searching process, some topics were found to yield diminishing results. For example, “HRMS” (human resources management system) and “LMS” (logistics management system) did not produce any sufficiently relevant search results to be eligible for inclusion. Furthermore, the fact, that the term “integration” can be used in so many contexts and has multiple different meanings, provided its own challenges to the search process.

## 2.2 Classification

The selected papers were categorized into ones with an organizational/managerial perspective and ones with a technical perspective. The division into these categories was conducted based on whether the article had been written from a viewpoint that perceived the information systems as white or black boxes and whether the emphasis was on the business side or the technical side. In other words, if the article included architectural details or covered technologies more specifically than just on a general level, it was considered as a technical paper. Therefore, technical papers could also contain organizational themes. The categories are further elaborated in subchapter 2.4.

## 2.3 Analysis and findings

In the analysis of the selected studies, occurrences of several relevant concepts were decided to be mapped. The studies and the concepts are listed in Table 1. Due to the concepts from SOA to iPaaS being mostly technical in nature and the ones from ERP to social media having also social aspects, they were chosen to be treated differently. For example, it was required that a publication had at least one section discussing ERP, while for SOA, a single mention was enough for it to be marked as a covered topic. This helped in identifying the papers that truly elaborated the concepts instead of just mentioning them.

Table 1: Concept matrix of selected articles

	Managerial concepts					Technical concepts									
Article/Concept	ERP	CRM	SCM	E-commerce	Social media	SOA	MSA	DW	EAI	Web service	ESB	API	Middleware	iPaaS	
Bayrak, 2013				x						x					
Malhotra & Temponi, 2010	x														
Metaxiotis, 2009	x														
Alsharari et al., 2020	x									x		x			
Buonanno et al., 2005	x														
Gupta et al., 2017	x														
Seethamraju, 2015	x														
Ahmad & Cuenca, 2013	x														
Federici, 2009	x														
Finnegan & Currie, 2010	x	x													
Alshawi et al., 2011	x	x							x						
Bose et al., 2008	x		x												
Dong & Yang, 2020					x										
Fraccastoro et al., 2021		x			x										
Keegan & Rowley, 2017					x										
McCann & Barlow, 2015					x										
Papachristos et al., 2014					x							x			
Yu & Ni, 2013	x	x	x	x						x					

Dai, 2009	x		x			x				x	x		x	
Lee et al., 2003	x							x	x				x	
Balina et al., 2017										x		x		
Al-Johani & Youssef, 2013	x					x			x		x			
Bidan et al., 2012	x					x		x	x	x		x	x	
Yan et al., 2008						x			x	x			x	
Rojas et al., 2021						x		x		x		x	x	
Gruner & Kassel, 2012	x					x		x	x	x	x		x	
Sun et al., 2011	x					x			x	x	x			
Peksa, 2021	x							x		x		x		
Andriyanto et al., 2018	x					x	x	x		x	x			
Andriyanto et al., 2019						x	x		x	x	x	x	x	
Andriyanto & Doss, 2020	x					x	x	x	x	x	x			
Bolloju & Murugesan, 2012													x	x
Kleeberg et al., 2014	x					x			x	x	x	x	x	x
Ebert et al., 2017									x			x	x	x
Serrano et al., 2017						x			x	x	x	x	x	x
<b>Total</b>	22	4	3	2	5	12	3	7	12	16	9	10	11	4
<b>%</b>	63	11	9	6	14	34	9	20	34	46	26	29	32	11
	<b>ERP</b>	<b>CRM</b>	<b>SCM</b>	<b>E-commerce</b>	<b>Social media</b>	<b>SOA</b>	<b>MSA</b>	<b>DW</b>	<b>EAI</b>	<b>Web service</b>	<b>ESB</b>	<b>API</b>	<b>Middleware</b>	<b>iPaaS</b>

Perspective: Business/Management, Technical Type: Critical factors/Background, Framework/Model, Implementation, Generic, Framework, Implementation

Figure 1 depicts the occurrences of the selected concepts in the articles. Each article having at least one mention of a specific topic counted as one occurrence of that topic. As can be seen in the figure, ERP is a fairly popular term in the integration literature. That can be explained not only by its importance to businesses but also by its ambiguity as a term. Some publications refer to ERP simply as a specific type of system while others view it as a strategy. Furthermore, the term can be used to describe a bottom-up integration approach as in the article written by Lee et al. (2003). The other concepts in the same category with ERP proved to be significantly less covered in the literature. For CRM and SCM, that most probably is due to them being placed under the category of ERP which leads to them not being discussed as their own entities.

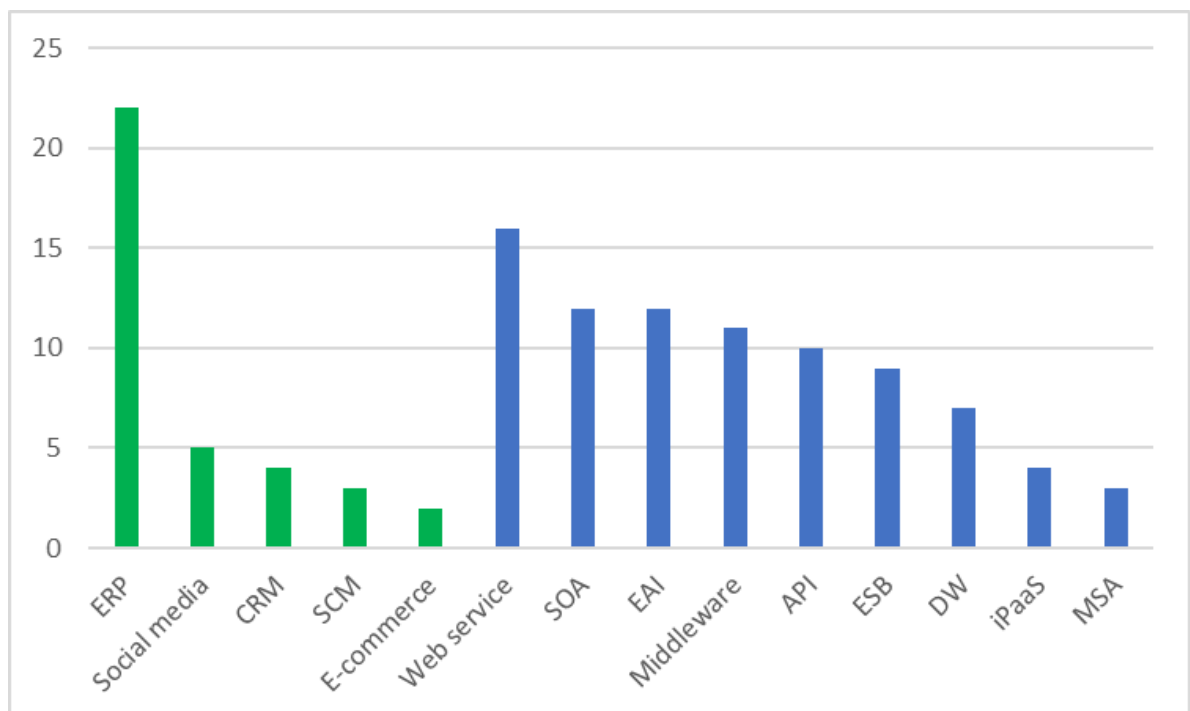


Figure 1. Occurrences of concepts in literature

As regards the technological concepts, Web service was mentioned in almost half (16 of 35) of the selected articles which made it by far the most popular one of them. This clearly indicates its commonness as a technology used in today's systems and applications. SOA, EAI and middleware were also prevalent concepts as each of them were mentioned in about third of the publications. The low occurrence of iPaaS and MSA is likely the result of their relatively late emergence in the literature.

One of the themes in the found literature, that should be noted, was cloud computing becoming the more popular subject, the more recently a paper was published. This trend can be seen in Figure 2 which represents the occurrence of the term “cloud” by year in the selected papers. Each point in the scatter plot represents the share of papers published during the year in question containing at least one mention of “cloud”. Based on these findings, it could be concluded that cloud computing has become increasingly important topic in the context of integration in SMEs during the past decade. This is not that surprising considering the potential cost-effectiveness of cloud service models for small businesses which have historically struggled to cope with the overwhelming costs of hardware investments.

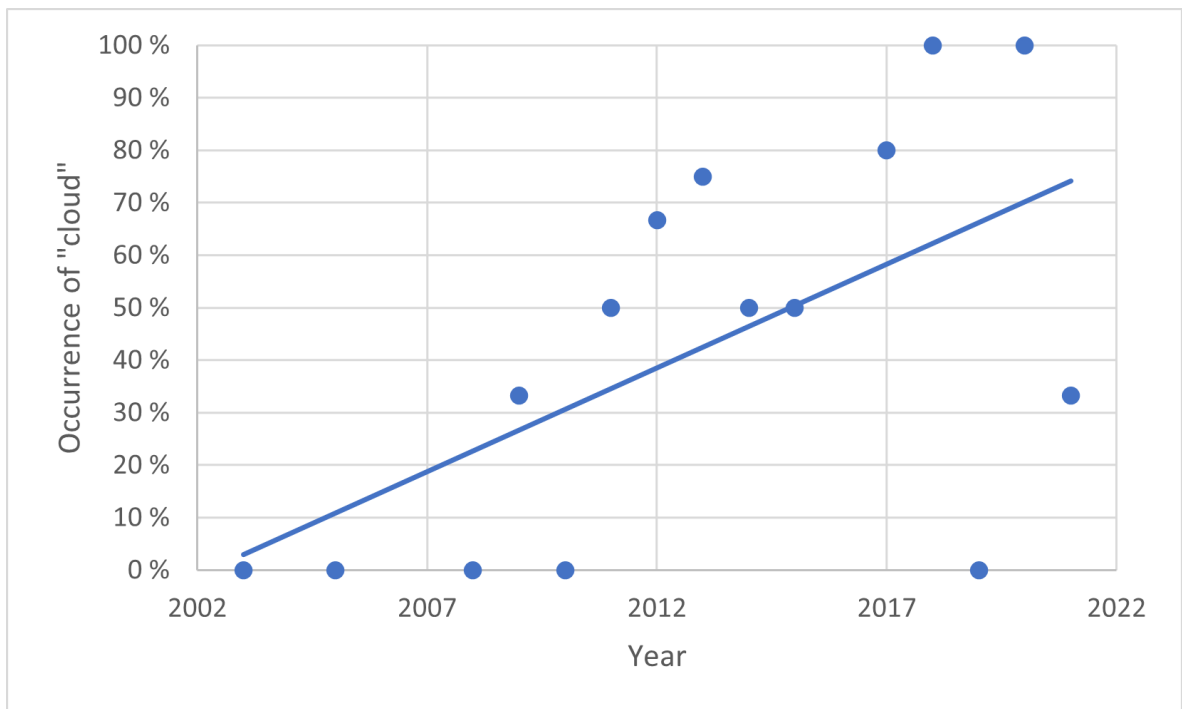


Figure 2. Occurrence of term "cloud" by each year in selected publications

All in all, the number of results on integration in SMEs was lower than expected (apart from ERP). The most probable reasons for this could include the research’s emphasis on larger enterprises and the lack of acute needs for integration from the small business point of view. For example, a company in an aggressive growth phase may indeed be in need of better integration but other projects are simply seen as more valuable use of limited resources.



## 2.4 Categories

For the contents of the next two chapters to be better understood, it is required to discuss the categories of the literature review in more detail. Categorization to technical and non-technical groups has also been done in the literature by authors such as Andriyanto & Doss (2020) and Lee et al. (2003). The organizational category, which is presented in chapter 3, takes a managerial approach to integration. Therefore, the emphasis is placed on the strategic implications of integrating different enterprise systems and social media with business processes. As stated in Table 1, the source material in organizational category generally included three types of publications: critical factors and background, frameworks and models, and implementations. The papers of the first of these types mostly studied the factors contributing to successful integration, while the ones of the second type recommended best practices to implement the systems, and the ones of the last type were about actual implementations.

The technical category, presented in chapter 4, focuses on the approaches and technologies used in integration rather than organizational aspects. In that group, three types of papers were identified: generic, frameworks, and implementations. The generic papers provided general descriptions of relevant topics, the frameworks gave guidelines for implementations, and the implementations described how integrations had previously been carried out. As a conclusion, the next two chapters summarise the most significant findings first from a managerial and then from a technical perspective.

### 3 Integration from organizational perspective

In this chapter, integration in SMEs is explored from the business and organizational management perspective. First, integration and implementation of different enterprise systems are discussed from the strategic point of view. After that, the focus is set on the opportunities that the integration of social media and its analysis can provide to SMEs.

#### 3.1 Enterprise systems: ERP, CRM & SCM

The origins of enterprise resource planning (ERP) date back to the 1970s when material requirements planning (MRP) systems were used by organizations for tasks such as production planning and scheduling. In the 1980s, a term called manufacturing resource planning (MRP II) was coined to describe the new type of systems that had evolved from MRP. The scope of MRP II was considerably broader and it therefore provided more functionalities. Finally, the term ERP was introduced by the Gartner Group in the early 1990s to describe the systems with even wider scope than MRP II. (Robert Jacobs & ‘Ted’ Weston Jr., 2007.) There are various definitions of ERP but in general it is described as a standard, customizable software solution which seeks to integrate the majority of business processes and functions into a comprehensive package (Buonanno et al., 2005).

After the initial hype around ERP was over, new systems appeared on the market. Customer relationship management (CRM) and supply chain management (SCM) among others were developed to meet the new requirements in the industry. The term ERP II was coined by Gartner in 2000 to include these systems and strategies under a single concept. To put it concisely, ERP II is a componentized extension of ERP with increased emphasis on inter-organizational processes. (Møller, 2005.) CRM aims to link front and back office applications to increase customer satisfaction and profitability of customer interactions (Chen & Popovich, 2003). SCM is concerned with management of relationships across the supply chain (Lambert & Cooper, 2000). Additionally, the most important ERP modules include for example accounting and finance, inventory management, and human resources.

Adoption and implementation of enterprise systems seems to be a relatively popular subject in the literature. Many studies have sought to identify and analyse the factors affecting the use of these systems in enterprises. Some of them have taken focus on the SME segment, as a study by Federici (2009) in which he evaluated the ERP introduction outcomes of Italian SMEs. The research found the most significant benefits to be the simplification of internal procedures, easier information retrieval, improvements in performance management, and increased production efficiency (Federici, 2009).

Malhotra & Temponi (2010) investigated the key decisions for small businesses to make for a successful ERP integration. The critical decisions they identified from the literature were project team structure, implementation strategy, database conversion strategy, transition technique, risk management strategy and change management strategy. Based on the interviews with American manufacturing companies with recent ERP implementations, they concluded that the odds of implementation success are enhanced by an assignment of a heavyweight project manager also acting as a project champion, partnering with an experienced external organization, performing a phased implementation of the ERP packages, adopting a manual database conversion strategy, and proactive project risk and internal change management. (Malhotra & Temponi, 2010.) ERP implementation was also studied from a similar point of view by Ahmad & Pinedo Cuenca (2013) who analysed the critical success factors for ERP implementation and their interrelationships in the implementation process. They found that while the quantity of identified organizational and operational success factors were about the same, 80% of top 10 factors were organizational (Ahmad & Pinedo Cuenca, 2013).

In a study conducted by Buonanno et al. (2005), the factors affecting ERP system adoption were studied by comparing the differences between SMEs and large companies. The results indicated that while business complexity is a weak predictor of ERP adoption, business size is a very good one. The primary reasons of not having adopted an ERP system for SMEs were not financial but structural and organizational. (Buonanno et al., 2005.) Alshawi et al. (2011) studied the organizational, technical and data quality factors in CRM adoption by SMEs. They concluded that the factors are largely similar to the ones affecting larger companies and that the adoption of CRM is influenced by the same kind of factors (excluding the organization size) that affect other studied ICT innovations (Alshawi et al., 2011).

A couple of studies have placed emphasis on the challenges in the implementation. Gupta et al. (2017) aimed to identify the critical challenges in adoption of cloud ERP for Indian SMEs and large organizations. Their study implicated that although most of the challenges were different between SMEs and large organizations, the challenges they both faced were business complexity, security, integration, monitoring, limited functionality, performance, and integrity of provider, of which the security was the most critical one for both (Gupta et al., 2017). A study by Seethamraju (2015) focused on the determinants and challenges in the adoption of SaaS ERP systems by SMEs. In contrast to the study conducted by Gupta et al. (2017), the security was found to be considered even better with SaaS model when compared to on-premise. Change management was instead identified as a key challenge of the post-implementation environment in all four case companies. (Seethamraju, 2015.)

### 3.2 Social media

The use of social media and web analytics has become a crucial part of businesses' marketing and sales strategies. These technologies can provide tools for customer relationship management via sentiment tracking and targeted advertisement campaigns which were previously much more resource consuming activities (Papachristos et al., 2014). According to Dong & Yang (2020), the use of diverse social media channels and big data analytics have a positive effect on market performance, which is even more substantial for SMEs than for large companies. Similar kind of findings have been made by Goh et al. (2013) who claim that social media engagement leads to increased consumer purchases and that user-generated content has a greater impact on consumer behaviour than content created by the marketer. Companies do indeed nowadays strive to recruit employees with social media experience and with individual brands suiting their own social media branding, who could help in building the company's image stronger (Happonen, Manninen, Hirvimäki, et al., 2021; Happonen, Manninen, Santti, et al., 2021).

The integration of social media is an important topic for the enterprises that intend to reap the benefits of these valuable communication channels. Understanding of how social media can be used jointly with other sales communication tools is therefore needed. Fraccastoro et al. (2021) found in their study that a sales process for international SMEs in the service

industry generally consists of three main phases: identification of new business opportunities, persuasion, and relationship management. They state that social media is usually used in the first phase, which is the identification of new opportunities, while digital and traditional sales communication tools are useful for the other phases (Fraccastoro et al., 2021). Another concern to take care of when implementing social media is to define its goals, objectives and metrics, and choose the most suitable platforms. Social media demands long-term commitment in communication to build and maintain the relationships with customers. (McCann & Barlow, 2015.)

After implementing social media in an organization, evaluation of its performance becomes relevant. Keegan & Rowley (2017) have developed a framework for social media marketing evaluation. It has six stages which are setting evaluation objectives, identifying key performance indicators, identifying metrics, data collection, report generation and management decision making. The most significant challenges related to the framework are the relationship between social media marketing agencies and their clients, and the availability of analytics tools. (Keegan & Rowley, 2017.) McCann & Barlow (2015) suggest that SMEs should measure the return on investment (ROI) of social media by using a three-stage framework consisting of planning, implementation and evaluation. The first stage involves setting goals, the second one implementing the tools, and the third one evaluating the short-term and long-term benefits including an assessment of ROI in the long run (McCann & Barlow, 2015).

## 4 Integration from technical perspective

In this chapter, the existing options for SMEs to achieve integration from the technical perspective are defined. The included topics are the solution types, approaches and technologies available for SMEs in software integration.

### 4.1 System integration solution types

Regardless of the nature of integration to be performed, information system (IS) integration solutions have three different tasks: data integration, application integration and business process integration. Data integration provides means for maintaining consistency between multiple heterogeneous data sources. Application integration unites multiple applications into an interconnected aggregate. Business process integration enables automation of business processes, provides interoperability between divisions and partners, and allows for more efficient decision-making in a company. (Kurz et al., 2001.) Integration solutions can be classified into inter- and intra-enterprise categories which are further elaborated in the following subchapters.

#### 4.1.1 Enterprise application integration

Enterprise application integration (EAI) is a solution that was developed for the problem of integrating multiple heterogeneous applications and data sources into a single enterprise application. This way, data and business processes can be shared among the connected information systems. (Linthicum, 2000.) While ERP requires business process reengineering, EAI enables an organization to continue the usage of their current systems and integrate new applications with them. Before the emergence of EAI in mid-1990s, integration of different enterprise systems required a lot of resources because they were integrated through point-to-point approach. EAI solved that by introducing the concept of middleware which acts as a bridge providing applications with a common communication layer with each other. (Lee et al., 2003.)

There are several different architectural approaches to implement EAI. The options include standardized communication protocols, data format mapping and transformation facilities, middleware and runtime containers, and UI integration technologies. To improve the interoperability of more and more heterogeneous EAI technologies, Web services and service-oriented approaches have been employed. (Kleeberg et al., 2014.)

#### 4.1.2 Business-to-business integration

Business-to-business (B2B) integration, also known as B2Bi, is a term referring to the integration of inter-enterprise business activities involving electronic message exchange (Bussler, 2003). B2B integration technologies need to be developed according to high standards due their criticality in interaction between enterprises. Therefore, they tend to provide significant amounts of reliability, availability, failure-tolerance, traceability, and security. (Kleeberg et al., 2014.)

The literature on the subject covers different kinds of frameworks and technologies for B2B integration in SMEs. For example, Yan et al. (2008) propose a B2B integration approach using Web services for SMEs. They used the approach to develop a B2Bi gateway for integrating business processes with suppliers (Yan et al., 2008). Bolloju & Murugesan (2012) analysed possible approaches for SMEs to adopt cloud-based B2B integration solutions. They suggest that SMEs should either adopt a SaaS solution and use its integration functionality, implement a combined SaaS and iPaaS solution, or integrate the existing systems through an iPaaS (Bolloju & Murugesan, 2012).

#### 4.2 Related technologies and approaches

SMEs are often faced with difficulties in information technology adoption due to the reasons such as organizational structure, knowledge gap in utilization of new data forms (such as open data), risk aversion or a lack of resources (Bidan et al., 2012; Metso et al., 2022). It is, therefore, crucial to choose the suitable technologies serving the needs of a small business with high cost-effectiveness, easy adoption, and reasonable maintainability. Some of the emerging technologies (Ghoreishi & Happonen, 2021) have been proven to provide

promising options (Ghoreishi & Happonen, 2020) for SMEs when compared to more traditional approaches.

#### 4.2.1 Application programming interfaces

Application programming interface (API) is a term used to describe programming interfaces for exposing the program's services for external systems. Today it usually means REST (Representational State Transfer) interfaces provided over HTTP (Hypertext Transfer Protocol) in JSON (JavaScript Object Notation) or XML (Extensible Markup Language) data format. APIs can be divided into public APIs and enterprise APIs, of which the former ones are built as consumable products while the latter ones are usually used to connect components in intra-enterprise context. (Clark, 2016.)

As a result of the rise in the popularity of APIs, the buzzword "API economy" has been created to refer to their utilization in creating additional business value. This model involves three key parties: API providers, API consumers, and end-users. Providers expose their assets or services over an API which consumers take advantage of to provide new services or products. End users are the ones who use the products and services produced by consumers. By providing an API, a company can gain benefits such as reduced costs, broader audience, increased brand loyalty, and new partnerships. (Heshmatisafa & Seppänen, 2020.)

Despite the potential benefits of APIs for businesses, it is common that companies with valuable data in their possession restrict data access to reduce competition. That also leads to reduced market transparency and limited innovation while hurting customers in the process. (Castro & Steinberg, 2017.) Furthermore, Heshmatisafa & Seppänen (2020) found that even the companies from the most potential sectors to provide generally available APIs did provide them surprisingly rarely. It therefore has been suggested that policymakers should consider intervention when there are no legitimate business justifications to restrict data sharing (Castro & Steinberg, 2017).



#### 4.2.2 Middleware

Middleware is a software layer that serves as a bridge between applications by homogenizing the diversities of distributed infrastructure. It allows applications to communicate with each other with clearly defined protocols. (Issarny et al., 2007.) With middleware, it is possible to connect applications that were not originally designed to connect with one another and therefore speed time to market. Some types of middleware are concentrated on specific kind of communication while other types of middleware can offer integration hubs for company's all systems. (IBM, 2021.)

Historically, the most common categories of middleware have included message-oriented middleware (MOM), remote procedure call (RPC), object request broker (ORB), and transactional middleware. MOM enables parties to communicate by using different messaging protocols. MOM can be classified in queue-based and publish/subscribe middleware. RPC enables a component to invoke procedures in another application running either on the same or remote host. ORB is based on request brokering between components, which is made possible by the Common Object Request Broker Architecture (CORBA). Transactional middleware provides an interface for running transactions in a distributed network of components. (IBM, 2021; Issarny et al., 2007.)

EAI has also its own middleware of which the enterprise service bus (ESB), until recently, has been the most popular approach. ESB is an architectural pattern that consists of centralized component handling communication between integrated applications. However, nowadays the traditional middleware solutions have been increasingly replaced by cloud-hosted services, such as integration platform as a service (iPaaS) model which is covered in another subsection. (IBM, 2021.) The cloud-based models enable SMEs to take advantage of integration possibilities without the need to purchase, install or manage any middleware or hardware.

#### 4.2.3 Data warehousing

Data warehousing is a paradigm created for analysing existing data for improved decision making. Data warehousing infrastructure is usually based on extract, transform, load (ETL)

approach. (Sharma et al., 2012.) While data integration is achieved with data warehousing, it does not support process integration due to lack of changes to business processes or systems (Bidan et al., 2012). In their study about integration approaches in SMEs, Bidan et al. (2012) found data warehousing to be largely less relevant in SMEs than larger companies. The first reason was stated to be data warehousing requiring a level of organization and maturity that SMEs do not often possess. The second one was that SMEs primarily aim for operational interoperability towards which data warehousing does not in itself contribute. (Bidan et al., 2012.)

#### 4.2.4 Service-oriented architecture and microservices

According to Niknejad et al. (2020), service-oriented architecture (SOA) can be generally defined as “an architectural concept that promotes loose coupling, reusability, interoperability, agility, efficiency, with a focus on breaking each business process into smaller blocks of tasks and functions such as services”. The services are used as independent units, each representing standard business functionality. Together with each other they form a unified business process.

SOA systems consist of service providers and service users. Service providers offer services for others to use and service users use those services. However, a service provider may also be a user of other services, and a service user may provide its own service. The connectors between the providers and users can be implemented with Web service technologies, such as SOAP or REST, and ESB is often used as a brokering component. (Bianco et al., 2007.)

Microservices are a type of SOA which have significantly risen in popularity since 2014. They are autonomous and single-purpose services leveraging well-defined interfaces in their messaging. As stated in Table 2, microservice architecture (MSA) is more loosely coupled, fine-grained and flexible when compared to SOA and its governance is distributed among multiple teams. Whereas SOA is suitable for large enterprise systems, MSA is used in smaller and usually web-based applications to achieve faster pace of development and better maintainability. (Rademacher et al., 2017.)

Table 2: Differences between SOA and MSA (Andriyanto et al., 2019; Rademacher et al., 2017)

	<b>SOA</b>	<b>MSA</b>
<b>Granularity</b>	Varying from fine-grained to coarse-grained	Smaller, single-purpose, fine-grained
<b>Independence</b>	Loose coupling	Decoupled
<b>Component sharing</b>	Share as much as possible; reused services	Share as little as possible; minimal dependencies
<b>Remote services</b>	Arbitrary number of protocols; often SOAP	REST
<b>Messaging</b>	ESB; synchronous; smart	API; asynchronous; dumb, fast and lightweight
<b>Service governance</b>	Centralized	Local, distributed
<b>Deployment</b>	Limited flexibility	Flexible and independent
<b>Application scope</b>	Large heterogeneous enterprise-wide or cross-enterprise systems	Small and web-based applications with few shared components

Although SOA and MSA were originally targeted for larger and more complex businesses, they also have their place in SMEs. One option is to use them in collaborative architectures for SME communities. That kind of collaboration can enable SMEs to operate as a single large unit reaping the benefits from economies of scale. (Andriyanto et al., 2019.) For example, Andriyanto et al. (2019) propose an inter-enterprise SOA framework for SME communities that combines features from SOA and MSA. The framework attempts to address the typical problems in SME communities, such as limited resources, heterogeneity and complexity, by striving to achieve simplicity, integration, and agility (Andriyanto et al., 2019).

#### 4.2.5 Integration platform as a service and other cloud services

During the last decade, IS integration has been largely affected by the rise of cloud computing technologies. The cloud computing paradigm moves computing resources from the physical boundaries of enterprise to cloud, from which they are provided as services via the internet. The main cloud service models are Infrastructure (IaaS), Platform (PaaS) and Software as a Service (SaaS). Cloud computing ideally creates a win-win situation where service providers get the benefits of economies of scale by increasing resource utilization

and consumers have the ability to scale on-demand while paying only for the used resources. (Kleeberg et al., 2014.)

IPaaS is a recently emerged type of integration platform for integrating enterprise applications in a cloud-based environment which have been proposed to solve the challenges posed by the inability of enterprise applications to expand beyond company borders (Kleeberg et al., 2014). IPaaS can be applied to cloud to cloud, cloud to on-premise, and on-premise to on-premise integration scenarios. When compared to traditional EAI platforms, the benefits of iPaaS include faster initial integration of new applications, reduced maintenance costs of existing integrations, and reduced complexity. (Ebert et al., 2017.) This is largely due to the lack of need to install or manage any additional middleware or hardware (Serrano et al., 2014).

There are several examples in the SME literature of utilizing cloud computing for specific integration tasks. Sun et al. (2011) propose a public SaaS platform for SMEs to integrate their enterprise systems behind one entrance portal. The platform uses SOA-based architecture and cloud service bus (extended ESB) which connects to the individual applications (Sun et al., 2011). Al-Johani & Youssef (2013) present a framework for cloud-based ERP. The proposed framework was concluded to reduce the overall costs significantly but security concerns were still perceived as challenges to be researched further (Al-Johani & Youssef, 2013). Balina et al. (2017) investigated the possibilities different cloud-based solutions offer for cross-system integration of knowledge management systems. They ended up proposing a centralized integration solution which supports adding new modules on the condition that they provide APIs for integration (Balina et al., 2017).

## 5 Implementation of integration tool

This chapter covers the empirical part of the thesis. First, the situation and the integration needs of the case company are described. Then the process to be integrated is described and an integration solution is proposed with a high-level architectural description.

### 5.1 Case introduction

The case company is a small enterprise operating in a B2B environment. They sell patented solutions to businesses in Finland and several other countries. The IT landscape of the company consists of a CRM system, sales leads database services, an ERP system (including inventory management, HR, payroll, and bookkeeping), bank systems, logistics systems, social media tools, website, web shop, extranet and other applications. As most of the systems and applications don't have plug-and-play integration options with the systems they need to be integrated with, data transfer between systems has to be currently performed manually. That in turn costs a lot of valuable working hours. Hence there is a need for integration and automation in the company.

The provided integration options vary depending on the system. Some of them offer freely usable and well-documented APIs, while others restrict the usage of their API behind additional payments or won't provide one at all. Also, one of the facts making the situation more challenging is the lack of pre-built integrations for the relatively less popular Finnish systems. Due to these reasons, many of the services' integrations require the engineering of customized solutions.

### 5.2 Process description and tool development

The integration problem that was decided to be solved for this thesis was the process of importing sales leads from a source information service to the company's main CRM system hosted in cloud. The leads consist of contacts, companies, and projects. As shown in Figure 3, the phases of the process are:

- Searching for the data to be exported from the information service by project name.
- Checking the search results, selecting the appropriate ones, and exporting them as CSV (comma-separated values) files.
- Importing the CSV files to the CRM system.

Before the implementation of the proposed solution, all the required data in the source information service had to be imported manually one by one to the CRM by an employee. With the tool, all the data could be imported in bulk.

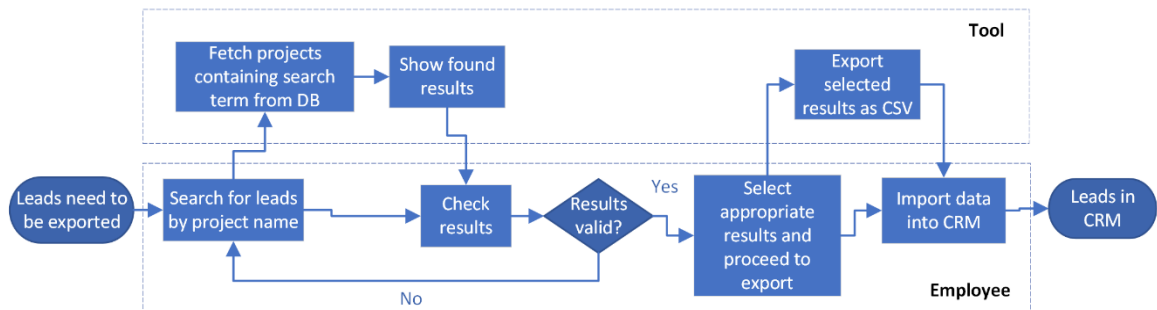


Figure 3. Process flowchart of transferring leads with proposed tool

From the user experience perspective, the proposed solution was required to be easy-to-use and preferably usable in web environment. This would allow the application to be used on both desktop computers and mobile devices depending on the situation, and it would also be accessible from anywhere without the need for additional installations. Therefore, the tool was decided to be developed and deployed as a web application.

### 5.2.1 Data integration process

The integration process started by defining what were the options to export data from the service and what information was needed in the destination system. It was found out that the service does not directly offer options for exporting the data in CSV, JSON or in any other file formats. Any API documentation was not available either. Therefore, reverse engineering the private API of the service was chosen as the method to be used for fetching the data.

One of the main questions at this stage was that what were the necessary data fields to be transferred between the systems. That was to a large extent defined by the database schema used by the CRM to store the projects, companies, and contacts. After an analysis of the schema was completed, the model illustrated in Figure 4 was found to be the appropriate way to transform the data. The process includes extracting the data from the information service API, transforming the data to correspond to the schema defined by the CRM, and transferring the data to the CRM database.

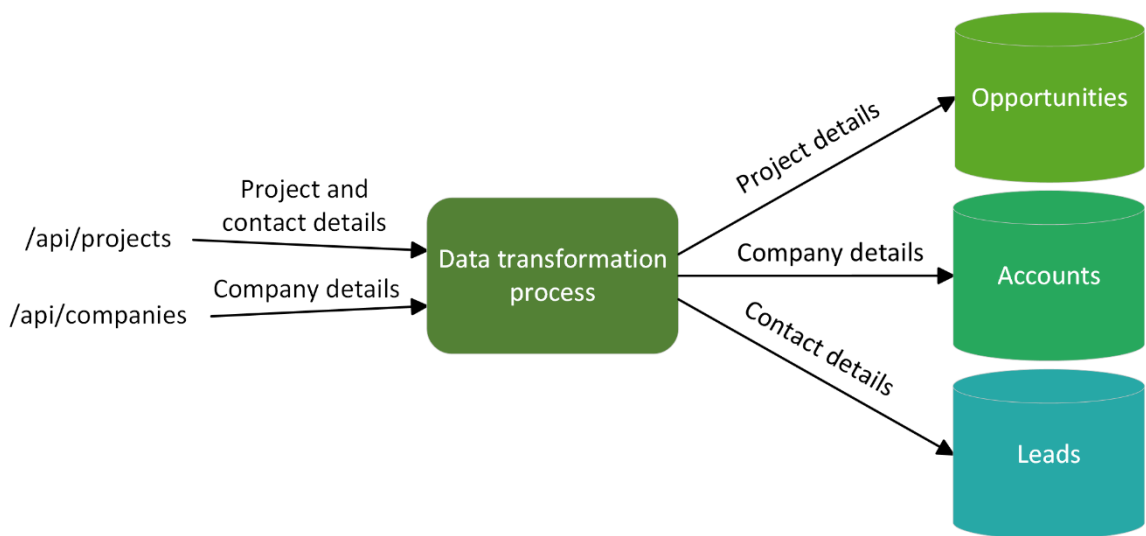


Figure 4. Data transformation and integration process

### 5.2.2 Tool architecture

As the solution was required to be a web application, suitable web technologies had to be chosen. React was selected as the used front-end library and Node.js as the back-end environment. Figure 5 depicts the architecture of the proposed solution. The React web application is the core of the tool. User accesses it from their browser and decides what data is exported. The searches performed by the user are directed to the Node.js proxy server which either queries the leads information service's REST API or retrieves the results from its cache. The proxy server also processes the searches and returns results based on the term defined by the user. The queries are executed using HTTP requests, and the format used for transferring the data is JSON.

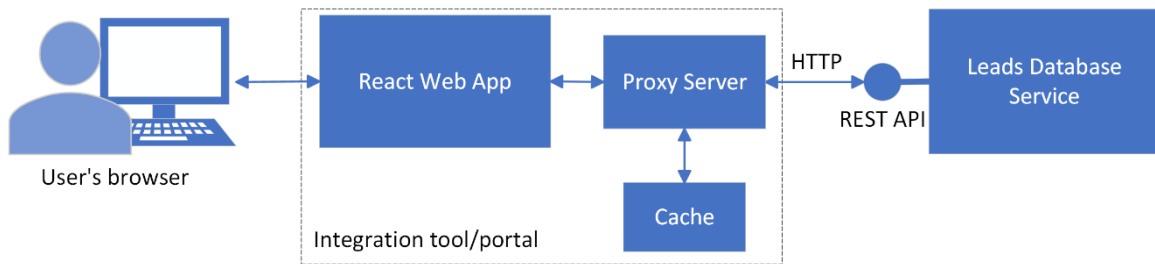


Figure 5. High-level architecture of proposed solution

A subject, that had to be taken into consideration in storing the data, was the compliance to rules such as the General Data Protection Regulation (GDPR). The GDPR is a regulation in EU law regarding the processing personal data. It states that any personal data should not be stored any longer than necessary. (EUR-Lex, 2016.) In the case of the proposed tool, the results retrieved from the source information system contained personal data. Therefore, the caching was implemented in a way that the any records containing personal data would be cleared regularly.

The architectural design of the solution allows the integration tool to be expanded in future into a portal containing multiple leads source systems. It should be possible with minimal modifications to the front-end authorization mechanism and by adding logic to the back end for querying the new systems. The only requirement for the integrated systems would be to provide APIs, although web scraping could also be implemented with some additional work removing the need for an API. The scalability of the design provides the case company with potential synergistic benefits achieved with the centralized architecture.

### 5.2.3 Tool's features

After signing in with their information service credentials, the user is faced with the search view which can be seen in Figure 6. Searches can be executed by using the text field. The wanted results are chosen by checking boxes next to each result. There is also an option to check all the boxes of specific project. To pin a project to be preserved for additional searches, the user can select the tack icon. This allows for the exportation of multiple projects at the same time. When all the wanted details have been selected, they can be exported by using the 'Export' button. As a result, the data is downloaded to the user's device as a ZIP





## 6 Discussion

In this chapter, the results of the research are reflected, and the findings are derived from the results. The results are presented as an attempt to answer to the research questions based on the literature review and the case study. Finally, the future outlooks for the research area are discussed.

### 6.1 Research questions

**RQ1: What are the possibilities and challenges of software integration in SMEs with limited resources?**

This question needs to be broken into several parts for it to be answered at a satisfying level. In the literature review, the topics were divided into organizational and technical categories, and therefore a similar type of division is applied here. Approximately half of the material in the organizational category was about the factors affecting adoption and integration of ERP in SMEs. Although ERP adoption is not the primary focus of this research, these papers do provide some important remarks about organizational integration of enterprise systems. The benefits of successfully integrated ERP system have been suggested to include minimised costs, improved quality of products and services, and increased customer satisfaction (Metaxiotis, 2009). Due to the revolution of cloud-based systems, SaaS ERP is more popular option than ever before. In addition to the mentioned benefits of ERP, cloud ERP systems can offer real-time data, better collaboration facilities, easier accessibility, and enhanced financial performance (Alsharari et al., 2020; Seethamraju, 2015). To gain these benefits, SMEs should pay attention to factors such as choosing a fitting provider (Federici, 2009), continuous evaluation of the integrated system, communication and co-operation (Ahmad & Pinedo Cuenca, 2013), assigning a project manager, and project risk and internal change management (Malhotra & Temponi, 2010). According to Gupta et al. (2017), the largest challenges of cloud ERP for SMEs are security, network dependencies, and subscription costs. However, Seethamraju (2015) discards the security as a critical issue by claiming that cloud model is usually more reliable compared to on-premise systems.

Another major topic in the organizational category was the integration of social media into SME business processes. The maximization of benefits from social media requires understanding the business area, and most importantly, setting concrete goals and metrics for social media performance. Only after these are achieved, can the suitable platforms be chosen. (McCann & Barlow, 2015.) The potential of social media analytics tools lie in generating new business opportunities and maintaining especially international customer relationships (Fraccastoro et al., 2021). SMEs are in a favourable position in this domain as they can get relatively more value from social media analytics with less integration effort than larger businesses (Dong & Yang, 2020). It must be, however, acknowledged that SMEs may face difficulties in aligning their business goals with continuous usage of social media tools (Papachristos et al., 2014).

The technical part of the literature review focused on the integration technologies and architectures available for SMEs. The challenges SMEs have in adoption of integration technologies compared to large enterprises are lack of time, knowledge, and skills. Furthermore, products on the market are often not suited for SMEs' needs. (Dai, 2009.) Their use of technology tends to be driven by interoperability rather than formal methods of integration (Bidan et al., 2012). Regarding the architectures proposed for SMEs in the literature, many of them seem to be based on SOA. Dai (2009) recommends demand driven and event driven SOA for SMEs to improve business agility through flexible services delivery. Rojas et al. (2021) present an SOA architecture with modifications to improve flexibility and performance which provided reduced costs compared to a monolithic architecture. Also Gruner & Kassel (2012) have used SOA as a guideline for their "Service Integration System". The system is similar to the SOA approach except for the reduced complexity achieved with standardized software modules. It involves a centralized middleware solution with just one interface. (Gruner & Kassel, 2012.) Moreover, an inter-organizational SOA model for SME communities has been proposed by Andriyanto et al. (2019). The model combines features from SOA and MSA to accomplish simplicity, integration, and agility (Andriyanto et al., 2019).

Cloud computing was as well found to be a promising technology for SME integration according to a lot of publications. The benefits of cloud service models for SMEs largely consist of the ability to access quality infrastructure and resources without an upfront

investment, and the flexibility to connect to the service anytime and anywhere (Dai, 2009). The cloud deployment also facilitates the collaboration between enterprises (Balina et al., 2017). For example, Bolloju & Murugesan (2012) recommend small businesses in need of a B2B integration strategy to either adopt SaaS solutions and make use of their integration capabilities, or combine SaaS and iPaaS.

Based on the empirical part of the research, many of the prevalent challenges of SME integration are related to the lack of openly available options for a system to be integrated with external applications. Although there exist all kinds of platforms with thousands of plug and play integrations, those do not usually include options for the local and less known systems. Furthermore, if the system to be integrated does not provide an affordable API access, there are few alternatives left. However, these challenges can most often be overcome, and the opportunities are increasing day by day. In the case of the implemented integration, the problem was decided to be solved by developing a middleware application querying to the undocumented API of the source service. Besides the used approach, a similar kind of integration problem could have been solved with an integration platform or even through robotic process automation (RPA).

### **RQ2: How can a business process be improved through integration in the case SME?**

A data exporting tool was developed to integrate a leads information service with a CRM system. The proposed tool was deployed in the cloud as a web application which enables it to be accessed from virtually any modern end device. Before the solution was implemented, the process in the case SME to be enhanced consisted of an employee manually and separately importing the details of each lead to the company's CRM system. With the introduction of the developed data export tool, bulk importing data became possible. This increased the potential efficiency of scenarios which involve transferring high number of leads from the information service to the CRM. The architecture of the solution was also designed in a way that allows for any future expansions for integrating other lead sources through the same web application.

## 6.2 Future

The integration options for SMEs are now better than ever before. Cloud computing has eliminated the need for expensive infrastructure investments and allows smaller businesses to flexibly scale their use of resources when necessary. The available options include a wide variety of platforms and SaaS solutions from which to choose the suitable ones for each situation. In the case of lacking integration alternatives, the integrations can also be built in-house or by outsourcing their development.

The availability of APIs remains as a critical development target for integration in future. The more APIs there are available, the more effortless and accessible integration becomes for enterprises of all sizes. According to Gravitee.io (2021), APIs are set to gain even more popularity with the growing demand for real time data. They stress the benefits of API-first strategy which values well-designed, fully documented, and consistent APIs (Gravitee.io, 2021). Therefore, the tendency of some companies to needlessly restrict API access only to reduce competition is still a challenge waiting to be solved.

This thesis used technologies such as APIs and web applications for making a business process more efficient. A suggestion for further research could be to approach the problem through the adoption of RPA. In this case, an RPA agent could, for example, take the employee's role in the process by logging in to the integration portal, downloading the CSV files, and finally import them to the CRM. Ideally, the only task left to be performed manually would then be to inform the agent about the details wanted in the CRM.

## 7 Conclusions

The objective of this study was to explore the possibilities and challenges of integration in SMEs. Additionally, the aim was to define the best approaches to achieve integration in resource-limited environments. A literature review and an implementation of integration solution in a case company were executed to accomplish these goals. The literature review investigated integration in SMEs from the viewpoint of the academic literature. The scarcity of results for the actual integration implementations was found to be surprising as a large share of the publications were focused on ERP integration and their perspectives were mostly managerial. However, there were also several implementations and frameworks of which most followed SOA. Another major, although not surprising, finding was the increasing dominance of cloud computing the more recently a paper had been published.

In the empirical part, an integration tool was developed for the use of the case company. The tool offers clear potential for a significant increase in the efficiency of leads transfer process. The most significant challenge encountered was the limited availability of API access provided by the integrated systems for SME-tier service agreements. All things considered, the results of this research suggest that while integration needs in SMEs surely exist, they are seldom perceived as critical enough to be prioritized over more acute matters. Furthermore, it is relatively straight forward to implement simple and light-weight integrations for efficiency improvements in the SME context, given that the enterprise possesses at least some resources with software expertise. The difficulties often emerge when larger integration initiatives are undertaken.

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