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Abstract

Majority of application integration projects fail to accomplish their goal. One of the main reasons for these failures is the lack of management and governance within the organization implementing the application integrations. Strategic and effective utilization of application integrations provides organizations with operational benefits by adding flexibility and reducing complexity of the information system landscape. Such advantages can be critical in current rapidly changing business environment. This thesis studies existing literature and research on application integration implementation and management and compares them with current practice of application integration work.

Prior application integration research presents Enterprise Application Integration (EAI) as a prominent solution for organizations application integration problems. EAI is a mere technical solution but rather an organizational integration scenario or a connecting layer between business and technical layers. Few methodologies and frameworks for application integration implementation exist. Articles presenting these approaches have practical implications and recommendations for implementing and managing application integrations within an organization. They include lots of organizational and managerial aspects and observations. Specific frameworks or methodologies for application integration management on the organizational level were not found.

An empirical study was carried out as a qualitative study by interviewing nine application integration professionals from five different software providers. Interviews considered three main themes: integration challenges, organizational integration capabilities and integration management. Respondents were asked to reflect their work experience and customer knowledge especially within application integration implementation projects. Most of the challenges and observations from the previous research were present in the results of this study. Management issues were seen having an impact for application integrations from the design phase until the maintenance phase. Five categories of general application integration management categories were presented to help outlining the complex and wide nature of application integration capability management.

Key words	application integration management, integration capability, enterprise application integration, enterprise integration methodology, application integration solution, application integration implementation
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Tiivistelmä

Suurin osa ohjelmistojen integrointihankkeista ei saavuta tavoitteitaan. Yksi tärkeimmistä syistä näihin epäonnistumisiin on puutteellinen integraatiotyön johtaminen ja hallinta integraatiota toteuttavassa organisaatiossa. Ohjelmistointegraatioiden strateginen ja tehokas hyödyntäminen mahdollistaa organisaatioille toiminnallisia etuja lisäämällä joustavuutta ja vähentämällä tietojärjestelmien monimutkaisuutta. Tällaiset edut voivat olla kriittisiä nykyisessä nopeasti muuttuvassa liiketoimintaympäristössä. Tämä opinnäytetyö tutkii olemassa olevaa kirjallisuutta ja tutkimusta ohjelmistointegraatioiden toteuttamisesta ja hallinnasta sekä vertaa niitä tämänhetkisiin sovellusten integrointityökäytäntöihin.

Aiemmat ohjelmistointegraatiotutkimukset erilaisia integraatoratkaisuja vastauksena organisaatioiden sovellusten integrointiongelmien. Enterprise Application Integration eli EAI ei ole pelkkä tekninen ratkaisu, vaan pikemminkin integraatioskenaario tai yhdistävä kerros liiketoiminnan ja teknisten kerrosten välillä. Ohjelmistointegraatioiden toteuttamiseen on muutamia menetelmiä ja viitekehyksiä. Näitä lähestymistapoja kuvaavissa artikkeleissa on käytännön esimerkkejä ja suosituksia ohjelmistointegraatioiden toteuttamiseen ja hallintaan organisaatiossa. Ne sisältävät erityisesti organisaatioon ja johtamiseen keskittyviä näkökulmia ja havaintoja. Varsinaisia viitekehyksiä tai menetelmiä ohjelmistointegraatioiden johtamiseen organisaatiossa ei löytynyt.

Empiirinen tutkimus tehtiin laadullisena tutkimuksena haastatteleamalla yhdeksää ohjelmistointegraatiotyön ammattilaista viidestä eri ohjelmistotoimittajayrityksestä. Haastatteluissa käsiteltiin kolmea pääteemaa: integraatiohaasteet, organisaation integraatiokyvykkyyttä ja integraatioiden johtamista. Vastajia pyydettiin pohtimaan työ- ja asiakaskokemuksiaan erityisesti ohjelmistointegraatioiden käyttöönottoprojekteissa. Suurin osa aiemman tutkimuksen haasteista ja havainnoista kävi ilmi myös tämän tutkimuksen tuloksista. Johtamiseen liittyvien ongelmien havaittiin vaikuttavan ohjelmistointegraatioiden käyttöönoton kaikissa vaiheissa, suunnitteluvaiheesta ylläpitovaiheeseen. Tutkimuksen tuloksena esitetään viisi yleistettävää ohjelmistointegraatioiden johtamisen kategoriaa, joiden tarkoituksena oli auttaa hahmottamaan ohjelmistointegraatiokyvykkyyden johtamisen monimutkaista ja organisaation laajuista luonnetta.

Avainsanat	ohjelmistointegraatioiden johtaminen, integraatiokyvykkyys, integraatoratkaisu, ohjelmistointegraatioiden käyttöönotto
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**UNIVERSITY
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MANAGING APPLICATION INTEGRATION CAPABILITIES

Master's Thesis
in Information Systems Science

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1 INTRODUCTION

1.1 Why do application integrations matter?

Information systems have become an obligatory part of corporate business. They can provide a competitive edge in the current complex business environment. In the 1990s companies' information system investments concentrated on Enterprise Resource Planning (ERP) systems which offered a possibility of enterprise-wide integration of information and business processes. ERP systems were designed for large business organizations as a tool of accessing the real-time information and gaining benefits of efficiency and competitiveness. ERP systems do not cover all the information systems needs in a company and the need for integration outside ERP systems exists. (Modol 2006, Mohamed et al. 2013, Themistocleous. et al. 2001)

Craggs states that over 70 percent of Enterprise Application Integration projects fail. He lists main failures as missing deadlines, blowing budgets or failing to deliver the service that the business was expecting. Integration Consortium organized a workshop in 2003 to identify the most common causes for these failures and generate a best practice guidance for improving integration project performance. Practical findings of this workshop are summarized as few "bear traps" for organizations to consider and benefit from the experiences of others. Main issues relate to the dual nature of integrations. As integration overlap both areas, business and IT, the problems are often related to the difficulty of combining these two areas of expertise within organizations. Ownership and accountability are unclear and lead to internal debate for resources. This problem often occurs simultaneously during the integration project and affects the progress of the project. Other issues that these influences are skill management, change management and interface definition conflicts. The more technically focused finding considers the lack of universal standards. Then fairly new industry included several standards and vendors, which pose challenges for organizations developing their IT by acquiring first comprehensive integration solutions. (Craggs 2004) The findings of the Integration Consortium emphasise the importance of internal management efforts of the organization in designing and implementing integration solutions.

In recent years, the growth of cloud services has changed the character of enterprise information systems. Software as a Service (SaaS) offers a new kind of possibilities for organizing the enterprise applications for companies regardless of size and industry. The

small and medium sized companies have also embraced information systems as a necessity. Digitalization in SME business is highest within the marketing and communication tools as 78 % of companies in Finland have Internet home page and 56 % utilizes social media. Cloud services are in use in 48 % of the companies. (Larja et al. 2019) Legacy systems are being abandoned at an ever-accelerating pace as information systems transformation into cloud multiplies. Gartner forecasts that the worldwide public cloud service revenue will almost double between years 2017 and 2021. (Gartner 2018)

1.2 Purpose of this study

This thesis studies the organizational capability to implement and manage application integrations in rapidly changing environment. Second paragraph aims to map the integration landscape and different integration methods based on the existing literature from the business perspective rather than technical perspective and indicate the connection between business processes and system integration processes. This section brings into focus the current transformation from on-premises environments to cloud-based environments. Third paragraph studies integration capability of an organization through integration management and integration implementation methodologies. The objective is to form a theoretical overview that summarizes the challenges in integration implementation and main features of integration management.

Empirical study aims to explore how the integration implementation professionals experience integration implementation challenges and customers management efforts. Nine software integration professionals from five different service providers have been interviewed. Interviews concentrated mainly on their experiences on the behaviour of the customer in integration implementation projects. Interviewees were also asked to assess the possibility to measure and estimate organizational application integration capabilities. Practical implication of this study is to emphasise the most critical integration management factors for organizations for enhancing their application integration management capabilities and updating them to better correspond the current environment.

1.3 Research gap

Information system integrations have been studied mainly focusing on specific target system or single integration project. Most of the research concerns the era of ERP and on-premises systems. Prominent literature and research focusing application integration management and implementation is more than ten years ago. Research gap for reflecting the past findings on integration management in the current, complex environment of information systems exists. The outsourcing of IT services has increased, and this study aims to reflect application integration challenges and integration management in the cases where one information system or both systems are from an external service provider. Perspective for the interviews is the software providers perspective. Selection of interviewees aimed to gain as large experience on wide range of customer projects as possible. Customer perspective was excluded to reach the most universal and generalized results.

2 DEFINITIONS

2.1 Application integration

Defining application integration in prior information system literature is complex. Some literature reviews for defining this concept have been done. Modol studied integrations from the inter-organizational perspective, Chowanetz et al. did research on existing literature. Both state that most of the research is based on case studies that has resulted a diverse concept of integration. This diversity is not considered as a problem, concepts are rather context specific. (Chowanetz et al. 2012, Modol 2006) Mohamed et al. (2013) also finds the concept of integration wider than sheer technical solution. They see it as being dependent on applications, data, and communication to add value for the organization. Therefore, integration is rather a socio-technical phenomenon constructing of data and processes. Lam et al. (2007) define enterprise integration as *“the strategic consideration of process, methods, tools and technologies associated with achieving interoperability between IT applications both within and external to enterprise to enable collaborative business process”*. Gericke et al. (2010) consider enterprise integration as an activity whose purpose is to solve a business problem. They propose that view of integrations has shifted from technology focused perspective to business focused, strategic, and valuable competitiveness enhancer.

Defining the difference between two similar concepts, integration and interoperability, specify the definition of integration. Belfadel et al. define interoperability as *ability of two systems to understand each other*. These two heterogenous systems utilize a common feature from either or share a mutual resource. Interaction can take place in one or multiple levels: data, services, and processes. The more levels the connection exists, the deeper is the interoperability. Enterprise integration has also multiple levels, for example physical integration, application integration and business integration. In the upper level the term integration is defined as a process that connects two different enterprise entities in order to reach common benefits. Two integrated systems apply standard way of communicating with each other and are tightly coupled. (Belfadel et al. 2017)

Lam et al. define five different levels of integration which are shown in Figure 1. Presentation integration is a joint view into data within multiple information systems. Data synchronization between two separate databases is considered as data integration.

In application integration an application offers functionalities accessible to other applications, for example application programming interfaces (APIs). Service integration consists of reusable services that are made available to multiple applications. Business process driven use of services constitute a process integration. They also distinguish two different types of integrations based on the manner the integration enables two different system to communicate with each other. Real-time integration keeps the information up to date simultaneously in all necessary systems. Advantages for this integration type are short processing times and faster data cycle. Asynchronous integration often relies on an export-transfer-load (ETL) architecture. ETL process is based on batches which are exported, transferred, and loaded according to a timed schedule. Asynchronous solutions are more inexpensive and easier to implement. (Lam et al. 2007)

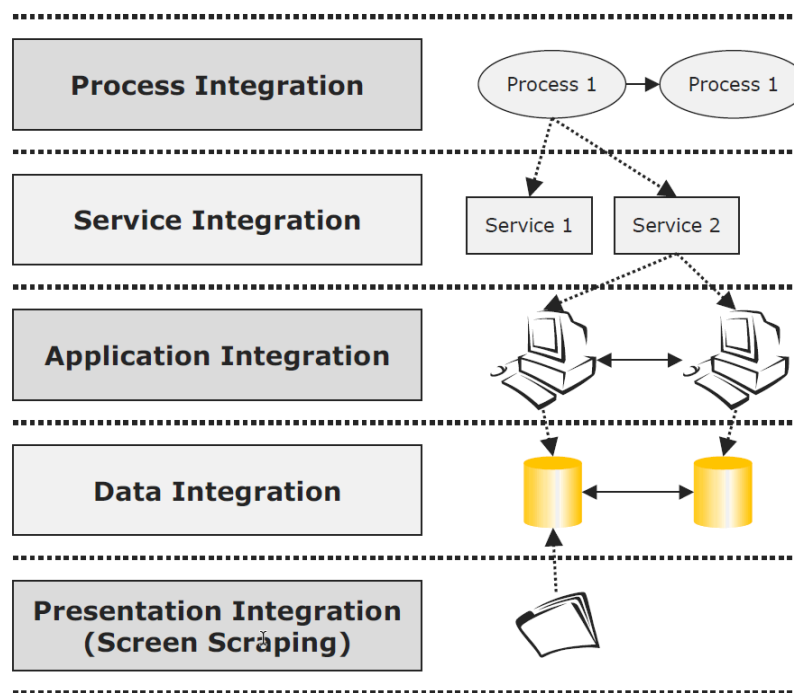


Figure 1 Levels of integration (Lam et al. 2007, 10)

A reference architecture (RA) offers structure and formalization through implementation of an integrated enterprise system. The ARDIN is a reference architecture which focuses on the business process as the basis for integrating enterprise system. It includes five dimensions shown in Figure 2. Enterprise development methodology in the middle controls the integration solutions and links them on business process vision. An enterprise integrated model interprets business processes to object-oriented form and offers

integrated viewpoint for enterprise design process. Information integrated infrastructure dimension aims to formalize the design in more detailed level. Fourth dimension, support tools, consists of technological elements which help to design, build and monitor integrations. The ARDIN methodology adds a new dimension compared to the previous methodologies, change management, to enhance life cycle perspective and support continuous improvement process. (Chalmeta et al. 2001)

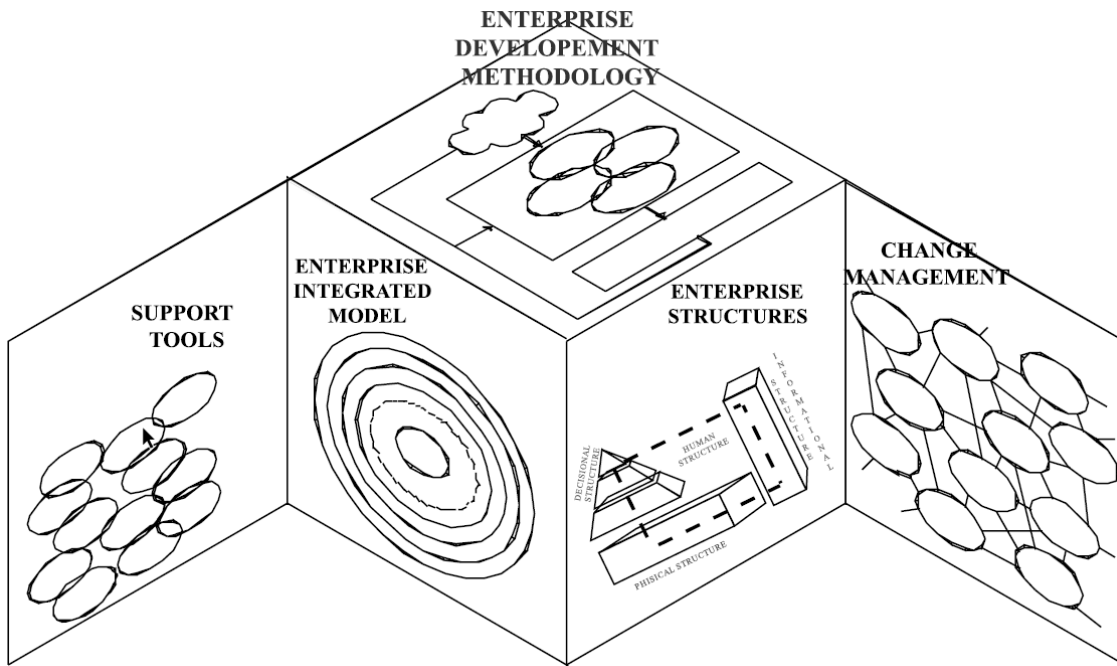


Figure 2 The five dimensions of the ARDIN RA (Chalmeta et al. 2001, 182)

Some traditional integration strategies are still current as legacy systems and diversity in enterprise system technologies exist. Hohpe presents different integration strategies and their advantages and challenges. First interactions between two enterprise systems were based on basic data transfer. Data can be delivered in files as a batch data exchange, via shared database or using specialized data transfer protocols straight from the source system to target system. These simple ways of transferring information have some advantages regarding the timing of the transfer. Batch data exchange allows independent timing in both systems. File can be created and used at different times. In raw data exchange the information is updated from the source to target in real-time. Remote Procedure Calls (RPC) and Messaging are point-to-point integration strategies, which have isolated layer for integration purposes. RPC are used between two distinct systems.

Messaging supports solutions with multiple systems, and it utilizes specialized Message Bus to deliver information. (Hohpe 2002)

2.2 Enterprise Application Integration

Lam et al. (2004) refer the technically enabled transformation of business processes as enterprise integration, which emerged with the spread of e-business. Enterprise Application Integration (EAI) is an enterprise integration scenario that is used to integrate existing, previously separate systems for better business performance. McKeen (2002) et al. define Enterprise Application Integration as *the plans, methods, and tools aimed to modernizing, consolidating, and coordinating the computer applications within the enterprise.*

Al-Balushi et al. state that EAI helps organizations to embrace the diversity of business, utilize IT better and link autonomous applications as a whole, but enable individual development efforts per application. It provides organizations with an integration method that allows the integrated applications, and their functions remain the same. It consists of the business processes and can be interorganizational or used between different organizations. Business benefits that EAI offers can also be cross departmental as it improves the sharing and availability of information. (Al-Balushi et al. 2016) Enterprise application integration was developed to solve ERP related integration issues as a more versatile solution than its predecessors. EAI is a layer between business architecture and technology architecture, usually in a form of a messaging service. This layer uses standardization of message formats and enables a certain level of independence for business process and legacy systems. (Hasselbring 2000)

There is not a single EAI solution that would provide all the functionalities needed by organizations. Assessing and selecting EAI solutions is not simple. Successful integration implementations require deeper understanding of information systems and requirements. (Themistocleous 2004) McKeen et al. advise managers to consider EAI strategies through several objectives: data, process, application, and inter-organizational objectives. (McKeen et al. 2002) Kamal summarizes the existing literature on integration layers as the REAL model which also consists of four layers (Figure 3). Application layer consists of applications which are integrated and is related to each other layers. Data layer is the common name for connectivity layer, transportation layer and translation layer, which each have important role in exchanging data between applications. Access points

between separate applications and EAI infrastructure form the connectivity layer. The transportation layer takes care of exchanging the application elements through these access points from an application to EAI and vice versa. The translation layer solves the differences in the structure of application elements by translating source format into a format suitable for recipient. Process integration level joins the business processes to the data-focused activities of data integration level. This level is an operator that serves the needs of the business process and guides application accordingly. Although previous three layers meet the basic need for process-related data exchange, Kamal adds the fourth layer. Knowledge integration level increases effectiveness of decision making by highlighting EAI's capability to also integrate knowledge from multiple sources. (Kamal 2011)

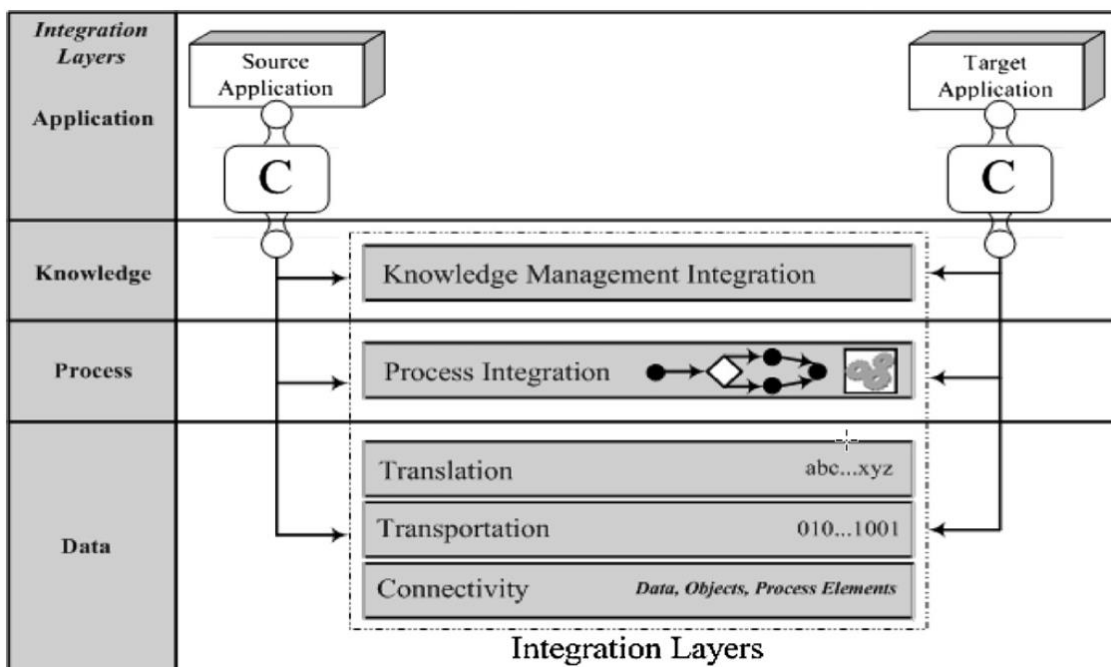


Figure 3 The REAL model (Kamal 2011, 297)

Figure 4 shows similar layered approach to EAI. This model adds the B2B element to the previous model. This model underlines the possibility of loosely coupled approach that EAI provides. EAI middleware acts as a communication agent between multiple application combinations. This enables systematic and flexible solutions for information exchanges in line with business processes maintaining application independence. (Li et al. 2013)

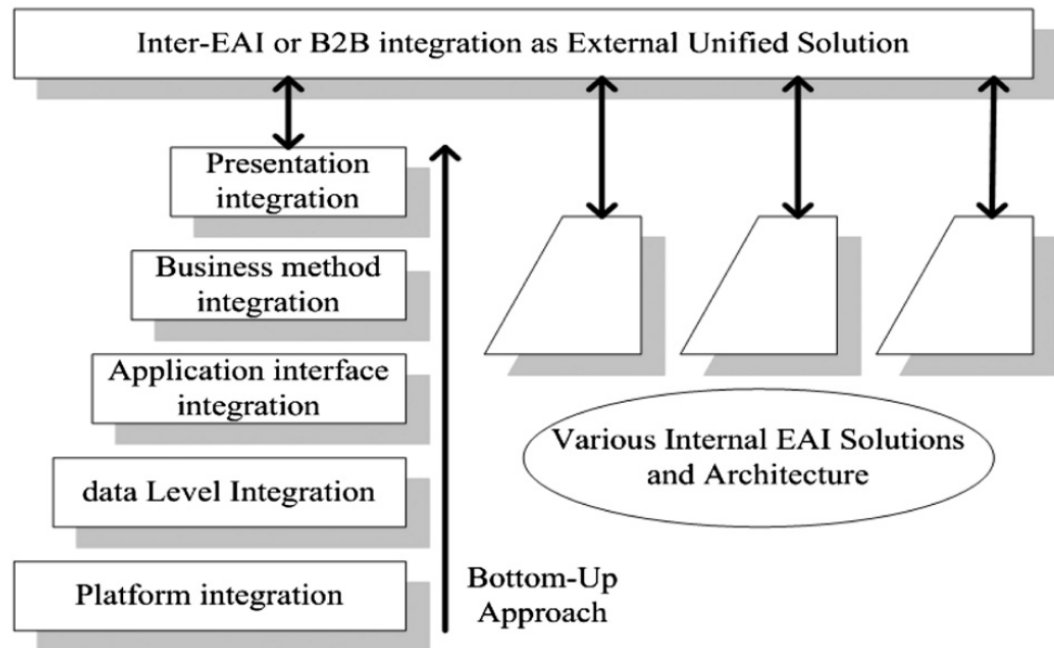


Figure 4 Layered approach for EAI implementation (Li et al. 2013, 584)

Another EAI framework which contains aspects of continuity is the framework presented by Tan et al. (Figure 5). Their proposal is formed using environment-based design and aims to resolve existing integration problems. The framework connects business processes, different company functions and resources with the workflow layer. These stakeholders and authorized parties access the workflow layer via applications in graphic user interface (GUI) layer. APIs serve as the technological integration layer and writers consider them being the future integration. Data management layer is the bottom layer of this vertically interacting model. (Tan et al. 2012)

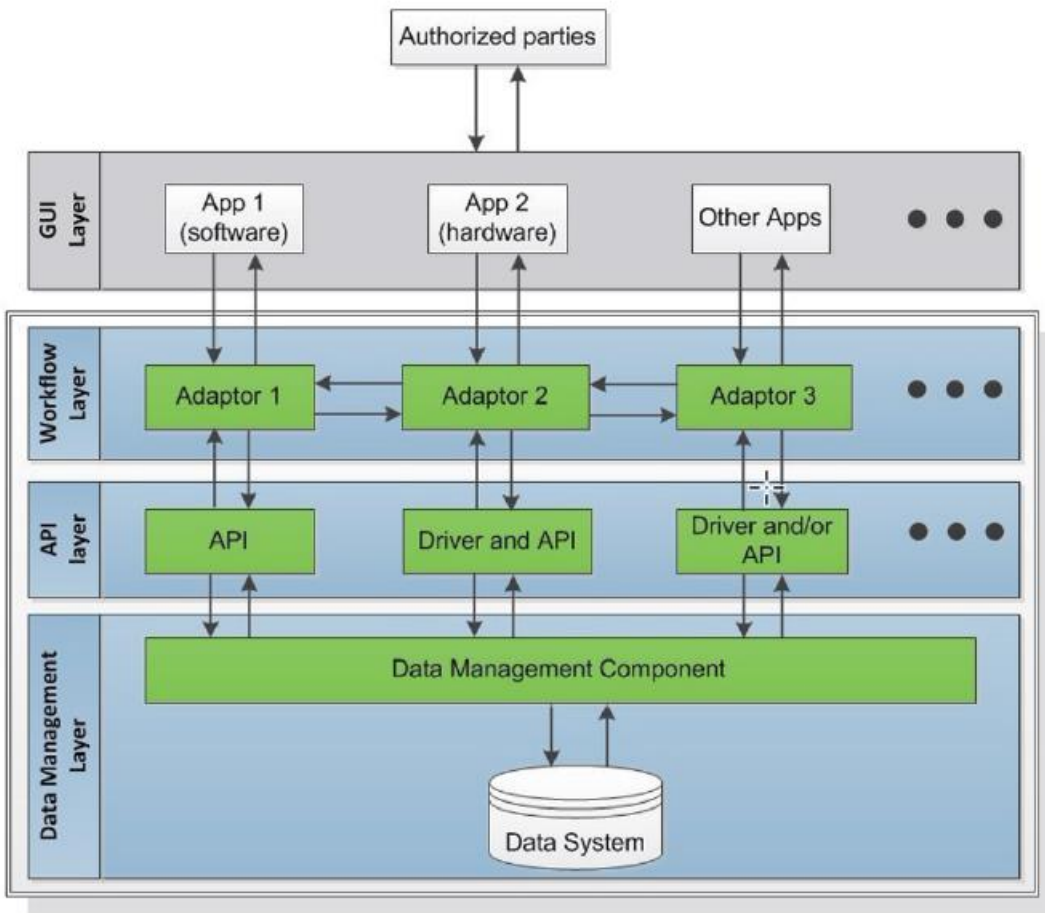


Figure 5 A framework for the EAI problems (Tan et al. 2012, 5)

2.3 Benefits and challenges

The question of benefits of integrations relates to the more generic issue of the business impact of information technology. Information technology investments and their productivity was at first dealt through the concept of Productivity Paradox as the positive correlation between them seemed absent, both on industry and company level. In the 1990s and 2000s many studies were done. Research showed only a small positive, but random impact on productivity. (Polák 2016) Dehning et al. present accounting research as a method of understanding the benefits of IT investments. Their literature review concluded that financial information technology investments have significant benefits for increasing market value. Direct connection between financial investments and stock markets or financial performance was not noticeable. Strategic information technology investments are seen as beneficial, but as potentially containing risks or costs. The valuation of investments on management of information technology is increasing as concept of information technology investments become more and more complex. Studies

show findings of a positive impact of contributions to development of IT management. (Dehning et al. 2002)

Chowanetz et al. did a review on information system integration research and identified nine studies on the impacts of integration. Those studies concentrated mainly on operational, managerial, and strategic impacts, infrastructural and organizational impacts were excluded. Integrations operational and strategic benefits were noted by majority of studies. A clear link between the level of integration and company's overall performance was found to be missing from the literature. Successful integration implementations had proven positive benefits, both tangible and intangible, direct, and indirect, but the combined results were difficult to measure and verify. (Chowanetz et al. 2012)

According Themistocleous et al., application integrations provide companies with capability to react faster on changes in their business and technical environment as no major changes are needed to existing systems. They serve as an enterprise infrastructure that adds business value by increasing productivity, enhancing the quality of services and relationships with their stakeholders. Cost savings were achieved by diminishing the number of systems, manual tasks, and maintenance. (Themistocleous et al. 2002) Similar finding was discovered by Modol, who did a literature review of inter-organizational information systems integration. Review shows direct and indirect benefits that are recurring. Direct operational benefits are automation of daily processes and cost reduction. Indirect, strategic benefits spread over a longer period and include improved partner relations and improving the responsiveness of business. (Modol 2006)

Bahli et al. summarize their findings of reasons and benefits of EAI adoption from existing literature as nine sources of motivation. The competitive pressure causes organizations to develop their competitiveness by integrating their computing resources for better utilization. Higher demand for web-based business and B2B integrations set higher standards for interorganizational integrations between diverse information systems. Tighter technical integrations enable tighter partnership relations also in other levels of business. Increased need for information within the organization and from the customers promote implementing integrations. Disparate enterprise applications make up *computing islands* that need to be connected for effective sharing of information. ERP systems include concentrated information but have their own integration problems. EAI helps organizations also to answer the multiple business demands, such as automating business processes and one-time data entries. (Bahli et al. 2007)

The advantages that EAI provides are presented in Figure 6 from the overall architectural perspective. Application spaghetti presents the situation where applications are connected by separate, parallel point-to-point interfaces. In this figure, EAI implementation is executed in a form of an EAI hub. Separate and centralized integration solution allows continued use of existing applications but produce a consolidated view of information. EAI includes the data transfer and transformation which are supplemented by business rules. Independent EAI solutions can be extended for external use and gives better opportunities to respond rapid changes in business environment and needs. (Achrya 2003)

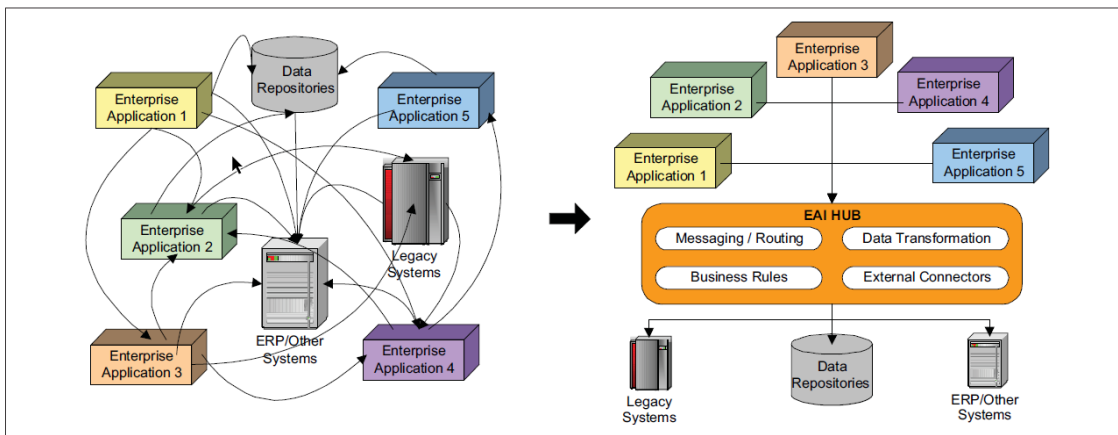


Figure 6 Application spaghetti vs. EAI implementation (Achrya 2003, 38)

Different technologies have been developed for managing organizations different processes and data. Yet the integration solutions need to accompany the current environment and complex systems. Kim links system integration challenges into three features of independent systems: autonomy, heterogeneity, and distribution. Autonomous systems are fixed into certain technology, which limits its integration capabilities. The concept of heterogeneity is related to variety of information system components that may differ between applications, such as hardware platform, operating system, database management and programming language. A large number of different components and complexity that exist due earlier individual development efforts can cause distribution challenges. These restrictions limit the integration options and need to be considered early on. (Kim 2017) As the article by Modol (2006) states, poorly implemented integration could cause new vulnerabilities and delays for operational functions.

Volkoff et al. studied enterprise system integration in three forms of integration: integrating similar business units, integrating the different stages of a business process,

and integrating different functional areas. Integration became more difficult, and achievement of benefits were less likely when the integration parties were highly differentiated. The study shows that standardization of processes and data is important for handling interdependencies. As the complexity increased the need for process discipline and data accuracy increased also. This caused conflicts between priorities for different business units. (Volkoff et al. 2005) The complexity of current environment emphasizes the need for strategic perspective to enterprise integrations. Lam et al. note that reacting separately to each integration need can lead to multiple resource consumption. Maximizing organizational integration efforts require a strategic thinking from an organization-wide perspective. (Lam et al. 2007)

Wagner et al. state that the large number of applications with heterogenous nature and the requirement for more effective support to business processes have stressed the relevancy of appropriate integration solutions. The main reason for enterprise EAI projects failure is the underestimation of the required effort. Such estimates tend to base on estimation models which are designed for estimating the development of individual systems. Such estimation models fail to regard all features of the integration needs set by all the concerned systems. Complexity on integration solutions is the result of the systems to be integrated and this makes the effort estimation of EAI projects more complicated than estimation of an individual system development project. After the literature review, they state that project management was considered as a success factor of EAI projects by several studies. (Wagner et al. 2015)

Tariq et al. (2012) state that 70 % of EAI projects fail due management issues. They summarize the main six issues as

- a shortage of limited skills
- lack of recognition that EAI is an architecture, not a product
- neglecting security, performance, and monitoring
- implementing EAI as part of another project
- going ahead without an integration strategy
- internal politics and poor communication.

2.4 Integrations in cloud computing

The reasons for companies transitioning to cloud services varies, but the main motivation is to adopt new technologies and business models in order of staying competitive. Business drivers of cloud transformation can be classified in four categories (Chang et al. 2010, 34):

- New opportunities for the enterprise, from changes in the business environment to the introduction of a new technology.
- Threats to the enterprise market share due to market or technology changes.
- Successful transformation of competitors prompts recognition of the need to change.
- Business performance degradation triggers the need to change to survive.

The concept of cloud computing differs from the existing business processes. Cloud resources can be reached whenever and wherever it is needed, and the Internet is available. This enables even the usage of enterprise applications with mobile devices. This offers lots of new opportunities for organizations to organize their IT infrastructure and information systems. Cost of investments are reduced as mandatory software and hardware purchases decrease. Shared resources offer also other kind of advantages, such improvement in performance and collaboration. Cloud computing has four hierarchical layers: SaaS (Software as a Service), PaaS (Platform as a Service), IaaS (Infrastructure as a Service) and the IT foundation (physical resources). SaaS is the most relatable with the traditional business processes as it provides the conventional software as a service. SaaS is based on the principals of ASP (application service provider). ASP provides customers with on-premises or outsourced installation of an application, which is only for the use of this individual customer. SaaS is a scalable solution where the software is maintained by the service provider as one instance and used by multiple customers simultaneously. (Kim et al. 2012)

Significant changes caused by this transformation are not technological but attitudinal. Organizations will be facing risks of reduced control over the infrastructure and information. Incomplete guarantees on service quality and availability of cloud computing are still existing weaknesses and obstacles for large organizations crucial applications transformation into cloud. (Marston et al. 2011) Importance of integrations is highlighted among this transition from on-premises information systems to cloud

environment. Prior organizational solutions and point-to-point -type of integrations need to be upgraded to meet environmental requirements. Especially when organizations data is partially in the old legacy systems and partially in cloud solutions. Linthicum calls this kind of combination of local systems and cloud solutions as pragmatic hybrid clouds. Modern data integration solution must support it and the features of both environments. The key for successfully solving integration issues in cloud computing is to understand that the traditional integration technologies need to be changed. This need arises from the increase in cloud-based systems but should base on the unique organization's own needs and solutions. (Linthicum 2017)

New forms of enterprise application integrations have been developed to be up to standard. APIs, Web Services, adapters, and integration brokers have added range of integration technology. These new solutions seek to respond the ever-growing complexity and performance challenges of data transformation for intra and inter organizational applications. New kind of applications have emerged in addition to existing integration needs and the change within them. Mobile and social applications have increased the total amount of applications that need to be integrated into business processes. Kolluru et al. propose a cloud integration strategy as a solution for managing integrations and their purposes effectively. Main purpose for this strategy is to define integration patterns for two main integration scenarios: Cloud to Cloud Application Integration (C2C) and On-Premises Application-to-Cloud Application Integration (O2C). Both scenarios have multiple sub-scenarios depending on the applications involved. The cloud integration strategy is based on the organizations core competencies regarding integrations and their integration capabilities. Main enterprise integration cloud scenarios are (Kolluru et al. 2013):

- on-premises application to cloud application integration
- cloud application to on-premises application integration
- cloud to cloud application integration
- B2B integration
- web API publishing.

Ebert et al. describe Integration Platform as a Service as the cloud-based, but less complex equivalent to Enterprise Application Integration. They present four similarities between these two integration methods: integration processes, data mapping, prebuilt adapters, and development functionalities. The cloud aspect of IPaaS emphasizes information security

and regulatory details. iPaaS solutions are divided into two categories based on the size of the user organization: private and small users and enterprise users. (Ebert et al. 2017) According to Marian (2012), iPaaS is a suitable method for cloud, B2B and on-premises integrations, within an organization and between organizations. When compared to on-premises integration solutions, iPaaS offers the possibility to purchase integration hardware and software as a service. Although iPaaS is a valid alternative for traditional integrations solutions, its suitability and utilization must be considered carefully. Martinez et al. (2018) propose an Enterprise Service Bus (ESB) as a solution for previous integration challenges in complex environment as a common platform. ESB is a framework for managing services as a mediator between service provider and clients which utilizes modern technologies to develop service-based flexible integration solutions.

While operating in such hybrid environment where some of the enterprise applications are located both on-premises and cloud, communication and system integrations become more relevant. The change has also brought new challenges that have not existed earlier. These challenges studied by Ritter et al. concentrate on the new technical problems. Issues relate to challenge of moving data between two different environments. Data should be transferred safely between the organizations internal network to service provides cloud solution or between two different cloud solutions. This transfer should also be monitored, and errors should be managed. Second technical issue which has become more relevant with the growth of communication need is the increase in volume of data. The number of applications and communication partners has multiplied. Scalable solutions need to be developed and constantly upgraded. Organizations need to be prepared to discover communication partners or applications that cannot be integrated in the technological level. (Ritter et al. 2017) Kanade proposes integration best practices for SaaS. Application specific tools and easy deployment may lead to unique point-to-point integrations. Instead, the usage of data integration framework or specialized SaaS application connectors is recommended. Mapping and defining all source and target systems, on-premises, or SaaS, is crucial for comprehensive integration architecture and design. Taking the future needs into account early on helps organization to develop scalable integration solutions. (Kanade 2019)

3 APPLICATION INTEGRATION MANAGEMENT

3.1 Managing application integrations

There are multiple reasons behind the managements interest for enhancing organizations information systems integration. Gleghorn states that two main reasons are the better ability to operate in a changing environment and meeting the complex requirements of organizations information systems. Data integration projects can add automation and reduce manual phases in data processing. This can lead to improved productivity and data accuracy. He notes that introducing enterprise application integration solution can help linking the business rules and technical data management. Well-designed and considered system integrations offer flexibility to organization for developing other IT projects. Renewing old legacy systems or introducing new applications is easier when system integrations are agile and up to date. (Gleghorn 2005) Lam et al. state that the importance of application integrations increases as organizations invest in ready-made applications instead of self-made ones and enterprise integration projects should not be merely technical projects. They raise the management issues as relevant as the technical issues in the case of integration challenges. Main management challenges relate to the interoperability nature of enterprise integrations as integration work often requires overcoming organizational silos and meeting the demands of wide range of stakeholders. The data can be widespread, or the hierarchy of data might be unclear because the ownership of data is undefined. Time and costs are noteworthy in terms of both the implementation of the integration itself and the impact of the integration work on the organisation's operational performance. They notice the need for enterprise integration expertise, within the organization or as an outsourced service. (Lam et al. 2007)

Kähkönen did a comprehensive study on enterprise system integration management. His study shows a need for recognizing the integration governance as a mean for mastering the complexity and integration problems. Most enterprise integration problems are derived from socio-organizational issues, organizational and managerial issues were more common than technical issues. He presents the concept of integration governance for ensuring that the integration solutions follow organizational goals. (Kähkönen 2017) In the related article Kähkönen et al. propose four recommendations for better integration governance. System acquisition and development decision making processes would benefit a bigger input from IT. The proper balance between IT and business is crucial as

utilizing new technologies can add value by automating and improving business processes. Establishing a high-level enterprise architecture defines organizations integration needs and is a key feature of the integration governance. Describing organizational integration needs and requirements clarifies the need for resources. Short term and practical implications of the enterprise architecture should be maintained as an architectural description of the system landscape. Fourth recommendation advises organization to enhance the intra- and inter-organizational collaboration and communication. The software vendors knowledge could be utilized to increase the organization's own integration governance capabilities. (Kähkönen et al. 2017)

Existing literature focuses primarily on implementing application integrations, but Bosch et al. observed that some challenges are due to the difficulties in choosing the suitable integration solution. Their study considers many application integration management challenges while defining a methodology for EAI solution selection. Application integrations tend to cross internal or external boundaries of the organization. Therefore, defining and understanding the enterprise problem domain helps to determine necessary stakeholders, processes, systems, and data. After the relevant factors are identified, it is possible to map and model the relevant data from the technical and business perspective. This helps organization to describe its existing data structures. Developing and inspecting their upper-level business processes helps organization to link them with data and infrastructure. (Bosch et al. 2010)

The increased usage of cloud services poses new kinds of challenges to organizations information management. These issues were studied by Ragowsky et al. Their study was done by examining the practical challenges within CIOs. They note that all information systems are not eligible to be transferred to cloud environment. This might be due regulatory, financial, or strategic reasons. The location of the systems to be integrated causes different stages of integrability within an organization. An integration that is difficult to implement may cause systems to be kept in the same environment and hinder the progress of the cloud transition. Maintaining such multi-platform and technically complex environment has generated new internal management challenges within the IT unit. Required skills have become more generalized than in-depth knowledge of a particular technique or system. Soft and organizational skills have become important as the focus has shifted from single on-premises system to integrating the complex set of different systems to business functions. Broad business and organizational skills have become a critical part of organizations IT skillset. Deeper integration between business

and IT unit has generated a need for wider training and education for users. Ragowsky et al. state that the rapid change and new demands can cause pressure to IT professionals and impair their ability to function as a bridge between technology and business functions. (Ragowsky et al. 2014)

3.2 Implementing application integrations

Smith et al. propose a roadmap for more successful and strategic enterprise integration. They propose 11 critical issues to be considered when integrating enterprise information systems. Starting point of an integration project should be meeting the objectives of the organization and adequate commitment within the organization. Scope of the project should be realistic and effective. Sufficient knowledge of an enterprise architecture or developing the architecture could help merging technology with business rules. Distinguishing which system dependent processes match business processes and which do not is also critical for developing business-oriented solutions. Legacy systems restrictions must be considered. Frameworks and standards can be useful and basic knowledge on them is an advantage. Two important issues are technological issues of specific data integration and comprehensive technological solutions for integration architecture. General project management aspects: project phasing, planning, and overall management, are also critical issues worth more attention. (Smith et al. 2002)

Lam et al. propose an enterprise integration methodology (EIM) as a framework and tool for enterprise integration (EI) projects. Key management aspects of EIM are process, deliverables and risks as presented in Figure 7. EI project is divided into five project phases. First phase is understanding the end-to-end business project from the organizational point-of-view and is usually also called as business process integration. These business processes are derived as various integration components. This ensures that the integrated IT systems and the integration solutions follow business processes. At this phase possible gaps between business needs and existing systems occur as needs for individual system development or manual tasks. These development needs and manual functions set the integration requirements and serve as a criterion for the integration architecture. Integration architecture describes the integration technology on a general level. More detailed plan of the integration architecture implementation consists of five steps: project scoping, project resourcing, integration architecture design and implementation, testing and as the last step; deployment and rollout. (Lam et al. 2004)

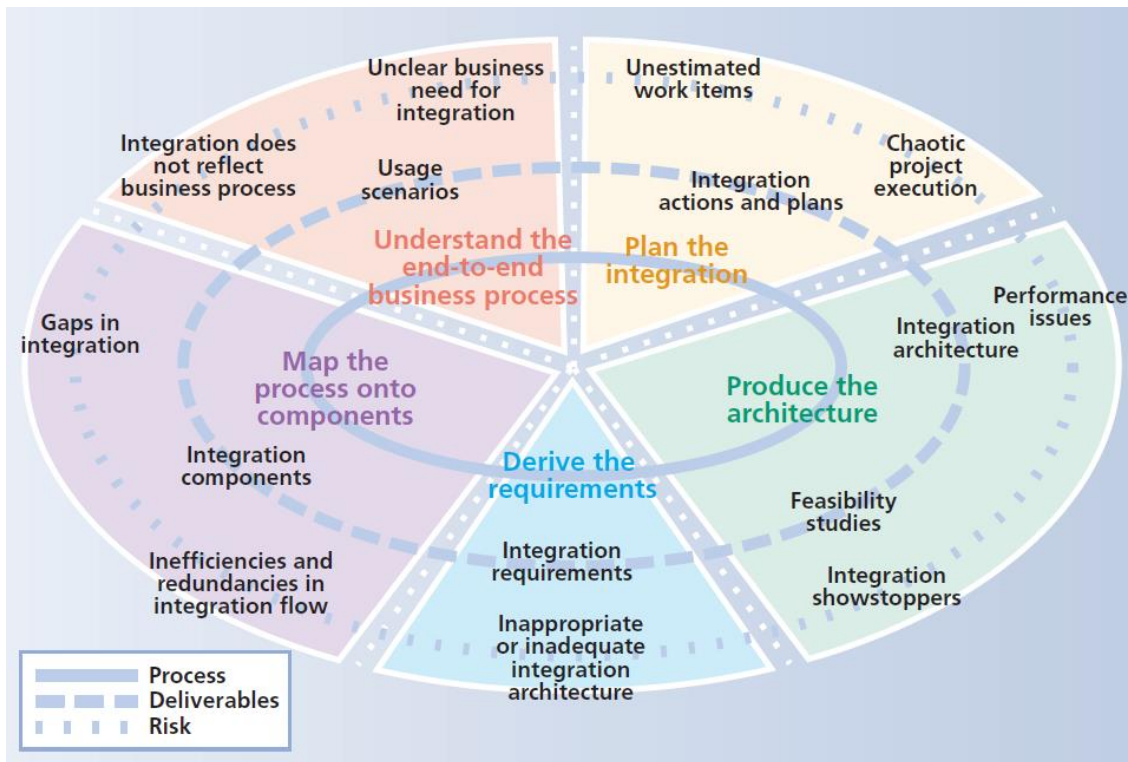


Figure 7 Overview of the EIM approach (Lam et al. 2004, 41)

Another EAI methodology is presented by Janssen et al. Their methodology includes four different features: way of thinking, way of working, way of modelling and way of controlling. The way of thinking phase means analysing the current situation (“as is”) and the presumable situation after EAI project completion (“to be”). The way of working defines the measures that reaching each desirable business process models requires. This modelling aims to reduce complexity and helps estimating the opportunities for added value of every model. Detailed simulations add information of the effects of proposed changes. This is called the way of modelling. Right stakeholders, such as technical and process experts and decision-makers, involvement is ensured by the way of controlling. This framework is adaptive and challenges organizations and stakeholders to focus to business perspective instead of solely technological approach to enterprise application integrations. (Janssen et al. 2005)

Organizations adopt enterprise integrations for many different reasons. Lam et al. divide these reasons under two categories: project drivers and organisational drivers. Project drivers emerge within other projects whose successful completion requires enterprise integration work. For example, acquisition of a new software alongside an old

legacy creates a need for enterprise integration project within the larger software development project. Changes in the organization may cause integration work when, for example, you want to eliminate overlapping of systems or when you want to organize information systems to adapt into organizational reorganization. (Lam et al. 2007) Themistocleous et al. studied why and how organizations adopt integrations. In the article focusing on the benefits and barriers of application integration they identify four different strategies of integrating custom systems (Themistocleous et al. 2001):

- creating a single unified unit of data by integrating existing custom systems
- development of an enterprise-wide integrated infrastructure by incorporating functionality from custom and packaged systems
- integration of their custom systems with e-business solutions to take advantage of Internet technology or improve collaboration with business partners
- implementation of an integrated IT infrastructure by incorporating functionality from custom, packaged and e-business solutions and thus, automate their enterprise and cross-enterprise systems and processes.

Kamal et al. analysed the existing EAI adoption models from the literature by executing an empirical analysis on local government authorities. They strived to create a new framework by discarding previous domain specific aspects that existed within previous studies. They noticed differences in EAI adoption based for example on the nature and size of the organization. Factors were arranged by their priority as a list for supporting decision-making and evaluating different integration solutions. The literature review identified 10 influential factors for EAI adoption based on former frameworks and models. Table 1 shows EAI adoption factors by categories in prioritized order. (Kamal et al. 2013)

Table 1 Influential factors of EAI adoption (modified from Kamal et al. 2013, 63)

Technological factors (TF)	Support factors (SF)	Financial factors (FF)	Organizational factors (OF)
-evaluation framework	-top management support	-return of investment	-barriers
-technological risks		-cost	-benefits
-IT infrastructure			
-IT sophistication			

These factors are mapped to different phases of adoption lifecycle. Writers have identified four different phases based on the literature. First phase is Motivation, in which the organization becomes aware of a new technology and is motivated to find out more about it. This phase is followed by Conception, a phase where the organization's decision makers deepen their knowledge and explore opportunities to utilize it. The Proposal phase formalizes this knowledge and proposes it to the rest of the organization. This also involves an assessment of their requirements and capabilities. The final phase is the Adoption decision phase, which can be divided into two separate levels: the organizational level and the individual level. Adoption decision is completed when the technology is acquired and utilized. Table 2 shows the factors with their priority within different phases. It presents a place number for each factor in each phase. For example, in the motivation phase the top management support and IT sophistication had the highest prioritisation result, followed by benefits. Costs were not considered as an influential factor in proposal phase and in adoption phase. (Kamal et al. 2013)

Table 2 EAI adoption factors (modified from Kamal et al. 2013, 69-70)

	Motivation	Conception	Proposal	Adoption decision
top management support	1		4	1
cost			1	2
return of investment			3	3
technological risks		3	2	4
barriers			7	5
benefits	2		9	6
IT support		1	6	7
IT infrastructure		4	8	
IT sophistication	1	2	5	

Al-Balushi et al. present 12 main categories of factors influencing the implementation process of enterprise application integration based on the Technology, Organizational and Environment (TOE) model. These categories are shown in the Table 3. This study confirms the observation from the previous studies that implementing enterprise application integration is not just a technological and environmental change. Most of the categories are positioned under organizational features. The two new categories discovered within this study (policies and project team) are from that category. (Al-Balushi et al. 2016)

Table 3 Factors influencing the integration implementation process (modified from Al-Balushi et al. 2016, 4)

Organizational	Technological	Environmental
<ul style="list-style-type: none"> -project team -implementation planning -requirements management -return on investment (ROI) -management support -policies -centralization -staff training 	<ul style="list-style-type: none"> -data security -data quality 	<ul style="list-style-type: none"> -market knowledge -citizen's satisfaction

Eight different organizational factors were presented within the proposed EAI implementation framework. Members of the project team have different roles from different parts of the organization. These roles and responsibilities are significant both individually and in collaboration as a team. Implementation planning should provide a plan to steer the entire EAI project. This plan should cover all participants and include a timetable and deadlines for the project. End-users' perspective and deeper understanding of their needs provide the basis for user requirements of an integration. Return of investment is in a form of data integrity rather than in a form of financial returns. Management support helps team members to commit to the project and helps with adequate resourcing. Integration policies should be established and followed. Centralization stands for centralization and utilisation of existing resources. Training of the staff includes mainly the knowledge of integration technologies. (Al-Balushi et al. 2016)

Bosch et al. did a study on the difficulties that organizations have in the selection of suitable application integration solution. Based on this they presented a method for choosing a suitable solution. The method regards the technical and the organizational aspects of application integrations. (Bosch et al. 2010)

3.3 Application integration frameworks and maturity models

3.3.1 Critical success factors for managing systems integration

Mendoza et al. proposes a framework for managing information system integration projects. Framework is based on the organization's integration maturity level. Previous literature has defined four different maturity levels that are based on company's current technology. Four different levels of maturity exist for companies that have some form of integration infrastructure (Figure 8). Pre-integration level is defined as having manual oriented data operations and individual systems with separate interfaces. First level of integration is named as Point-to-point integration. This level has a detached, simple information exchange infrastructure far away from the business process. Second level of integration, Structural integration, is also missing the tight coupling between infrastructure and business process, but the transfer of data is more controlled and standardized. The Process integration level adds the aspects of business process and information management to the flow of information. This third level has much higher level of automation. The top level of integration is External Integration. In this level the integrations exceed organizational boundaries and include high-end middleware and up to date technological solutions. Integration have become a part of business process and they add value to the company. Organizations tend to gradually work to raise their level of integration. (Mendoza et al. 2006)

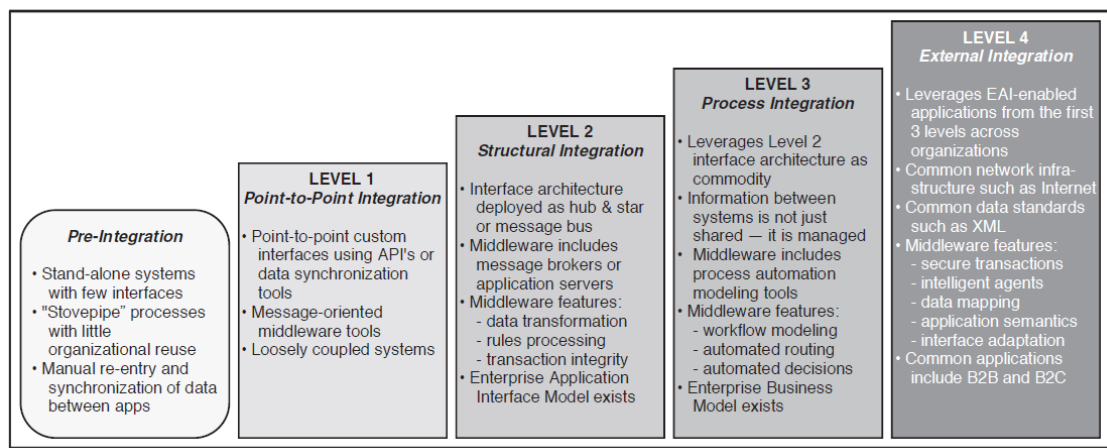


Figure 8 Integration levels (Mendoza et al. 2006, 57)

As a summary, Mendoza et al. (2006) propose 20 Critical Success Factors for managing systems integration. These factors are meant as a measuring tool for integration projects. Organizations can use this framework for evaluating their current integration level and

setting the target integration level for an integration development project by narrowing down the number of factors to consider. Critical Success Factors are divided into two different categories: specific and general. Specific factors belong only under certain integration level, general factors can belong under multiple integration levels. Table 4 includes all these factors divided under each integration level. CSF can be utilized as a check list for organization to develop their system integration capabilities and level of integration by measuring their current strengths and weaknesses.

Table 4 Critical Success Factors (modified from Mendoza et al. 2006, 59)

Integration level	Level 1: Point-to- point integration	Level 2: Structural integration	Level 3: Process integration	Level 4: External integration
Critical Success Factor				
Appropriate configuration of the communication software	X			
Standard data model documentation, unification and updating		X		
Appropriate outsourcing management		X		
Known organizational structure			X	
Change determined and justified at a productivity level				X
Valuable support by senior management				X
Adequate management of project scope				X
Appropriate strategy of security				X
Effective outgoing and incoming communication				X
Significant administrative support for the project	X	X	X	X
Complete technological infrastructure	X	X	X	X
Effective project leadership	X	X	X	X
Valuable project management	X	X	X	X
Relevant user involvement		X	X	X
Effective internal and external training plan		X	X	X
Effective organizational change management			X	X
Low impact of information systems on the organization			X	X
Careful strategy of implementation			X	X
High-expertise project team			X	X
Helpful technical support			X	X

3.3.2 Success Factors of Application Integration

Gericke et al. identified 27 Success Factor Candidates for application integrations based on literature and analysed them by using five measurable Success Indicators. They summarize their study into seven main factors that relate most to the application integration success. These factors are presented in Table 5. All Factor candidates were measured with five different Success Indicators which each define an achievement as a proof of success in certain area. First indicator of success would be achieving the target quality of business process support. An application integration aims to connect separate information systems as a whole that adapts to the business process and lead to higher quality in supporting business process. A higher user satisfaction is the second result of the increase of quality and agility of application architecture gained with successful application integrations. The added agility also decreases of the overall duration of product and service deployment. Last two success indicators relate to organizational flexibility of application architecture which leads to operational efficiency. Wider choice of software and IT-decisions can also lead to cost savings. (Gericke et al. 2010)

Table 5 Application Integration Success Factors (modified from Gericke et al. 2010, 684)

Factor	Description
1 - Architecture management	strategic aspects of architecture management, integration strategy
2 – IT/Business Alignment	business-IT cooperation capabilities, business driven IT
3 – Use of Methods	method-based process, integration patterns
4 – Organizational Maturity	architecture/integration management, development, planning, documentation, and clear responsibilities
5 – SOA	service-oriented principles, different layers
6 – Consolidation of Applications	simpler application landscape, easier integrations
7 – Technical Infrastructure	dedicated infrastructure and standards, higher technical quality

Organizational maturity consists of five Success Factors Candidates by Gericke et al. (2010):

- integration expertise
- quality assurance
- coordinated and integrated processes
- documentation of IT processes
- clarity of responsibilities.

Expert knowledge on application integrations is noted as a success factor in multiple sources. It should also be considered when assigning tasks within integration implementation project. Application integrations, which are planned sustainably, are more likely to ensure high quality. Reaching strategic integration goals requires broader coordination and integration of organization wide processes. Application integration documentation serves as a basis for process implementation and optimization. Clarity of responsibilities helps to manage the large number and diversity of roles related to application integrations. (Gericke et al. 2010)

3.3.3 Critical success factors in enterprise application integration

Lam studied Critical Success Factors (CSF) in Enterprise Application Integration found in the existing literature via a case study. He categorized three main groups of CSFs: the rationale and support for EAI, the strategy for EAI to be used within the organization and project planning for EAI and implementation of an EAI solution. Based on the research, he proposes a new model for critical success factors presented in Figure 9. In the first category, also named as the top management support, appeared to be the most important factor of EAI success. This organizational feature was dependent on the sub-factors: good organizational and cultural fit and a strong business case for EAI. The category of overall integration strategy had also two sub-factors: business process changes and overcoming resistance to change and technology planning. These two categories are mainly allocated under organizational features whereas the third group of Critical Success Factors include four project-related features. Those were realistic project plans and schedule, use of right EAI tools, client involvement, communication, consultation and training and proper migration approach. Lam notes that there are two distinctive features of EAI projects that

differentiates them from other information system projects. EAI projects usually based on existing limitations and constraints of applications to be integrated. Also, the applications are located across the organization and developing a comprehensive integration strategy demands broader perspective which transcends the internal boundaries of the organization. (Lam 2005)

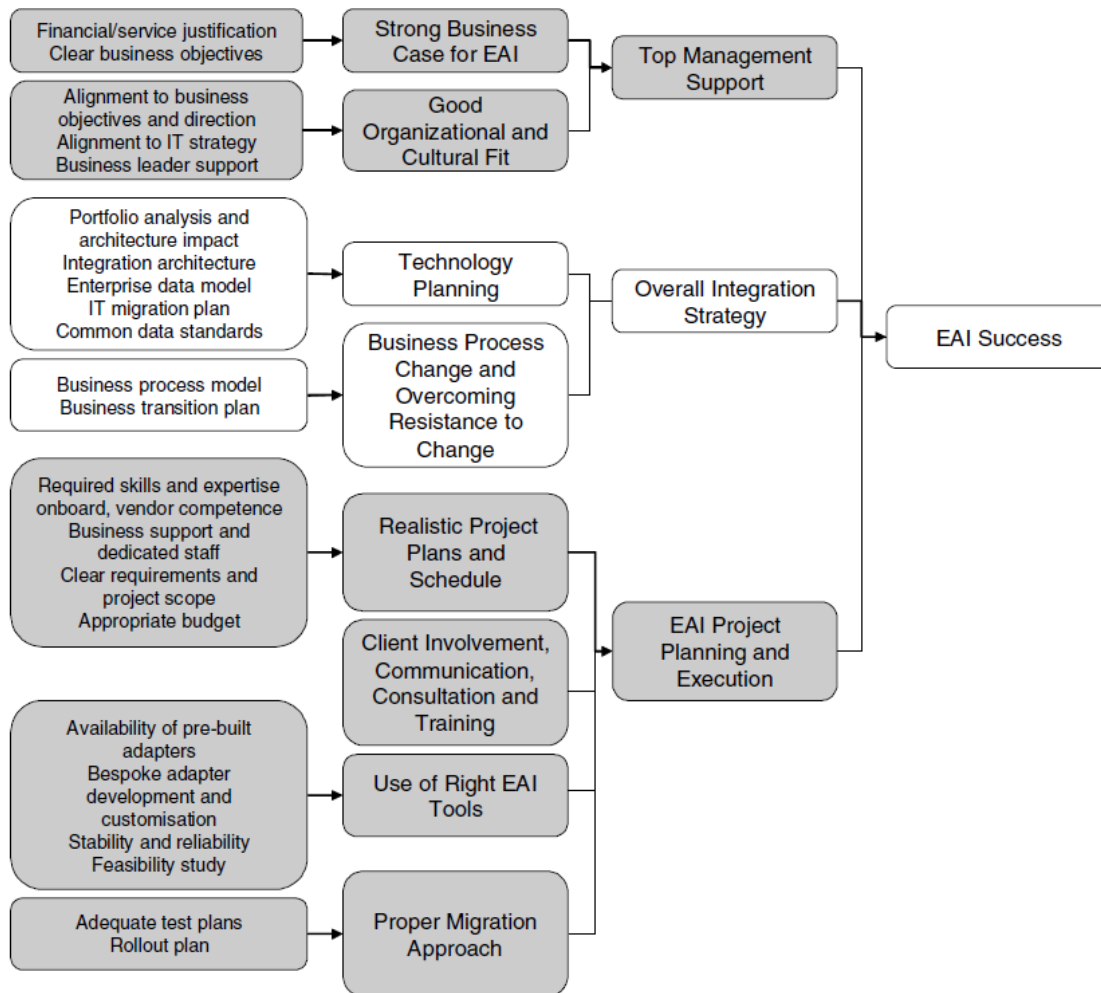


Figure 9 CSF model for EAI (Lam 2005, 184)

Lam also presents practical implications that were present in the literature and confirmed by his study. He emphasizes the different nature of EAI project regarding other information system projects. Existence of specific EAI skills within the organization planning an EAI implementation project should be surveyed and developed or acquired externally if necessary. The integration need should be first addressed in the business level by mapping the current processes, weaknesses, and development opportunities before regarding more detailed and technical choices. Lam notes the importance of

enterprise architecture as a way to model organizational data. He advises organizations to build an enterprise data model or prepare to process this subject as a part of the EAI project. (Lam 2005)

3.3.4 Success factors and performance indicators for enterprise application integration

Schwinn et al. analysed five success factors for application integration. They also present a central figure, which acts as a focus of success factors and has dependencies to all other five factors. This central figure, agility of the information system, is the also the main goal of application architecture design. It is defined as *the ability to react to upcoming new or changed requirements*. Requirements can be technical, or business driven. Five success factors aim to promote the agility but have interdependencies between each other. Reducing complexity in the application landscape helps organization to manage the complexity caused by increased number of applications. Schwinn et al. propose disintegrating the application architecture as a way to control the complexity. Second feature impacting the agility of the information system is the degree of coupling. The appropriate level of coupling is application relation specific and standards for it are difficult to define. Writers propose modification costs of each application relation as the implication of the level of coupling. Developing and maintaining a function only once is a sign of optimal reuse. Maximum reuse can be enabled by centralizing functionalities utilizing a middleware. Software components reuse potential is also dependent on its level of specification. The more generalized the component is, the more commonly it can be used. Remaining two success factors relate to financial aspects of integration. Integration expenses derive from two main sources: integration implementation project expenses and IT expenses which are determined by the number of used integration technologies or tools. (Schwinn et al. 2005)

3.3.5 Maturity models

Integration Readiness Levels (IRL) aims to measure the integration maturity in detail between two different systems from the technological perspective. Sauser et al. present nine levels of integration readiness. These levels are divided into three stages of integration definition: semantic (IRL 1-3), syntactic (IRL 4-7) and pragmatic (IRL 8-9). Integration readiness levels increase in chronological order from IRL 1 being the start of

the process as the selection of the medium for integration to IRL 9 being reached when the integrated technologies are in use successfully. This model is not designed to be used as an independent assessing tool and lacks many aspects of business perspective. (Sausser et al. 2010)

The framework of Cloud Data Governance Maturity Model aims to respond to the change driven by development of cloud computing and big data technology. Cheng et al. (2017) define CDMG 23 different process areas that are composed under six core areas:

- cloud data strategy
- cloud data management
- cloud data quality
- cloud data operations
- cloud data architecture
- security and privacy.

They position the process area of data integration and interoperability under cloud data operations. This process area considers data integration comprehensively based on sources, formats, and logical and physical characteristics. Interoperability is defined between cloud servers. Maturity assessment can be done as a self-evaluation or by a third-party assessment. This cloud data governance maturity model measures over-all maturity as a sum of all these core areas in five different levels, from low to high, performed to optimized. Each process area can be given its own maturity level and the maturity level of each core area is defined by the lowest value its process areas. (Cheng et al. 2017)

Another cloud data governance maturity model is proposed by Al-Ruithe et al. Their model includes ten domains of organizational competencies of cloud data governance. These domains are:

- data governance structure
- data governance function
- cloud deployment model
- service delivery model
- cloud actors
- service level agreement
- organisational
- technical

- environmental
- measuring and monitoring tool.

This article presents the cloud data governance maturity measurement matrix as a tool for organization to assess their current data governance readiness. The matrix gives details for each ten domains in five different levels of maturity. Al-Ruithe et al. 2017

Kolluru et al. present a Cloud Integration Maturity Model as a first step for organizations for creating a cloud integration strategy. The model is a tool for enterprises to assess their integration capabilities from the cloud perspective. Like other maturity models, it aims to map the current needs and state of an entity and suggest the aspects that need to be improved. The maturity model is presented in a form of a Cloud Integration Assessment Questionnaire (CIAQ). Questionnaire focuses on organizational-specific issues with 16 questions on multiple areas. (Kolluru et al. 2013)

4 EMPIRICAL STUDY

4.1 Methodology

The research for this thesis has been carried out as a case study. Eriksson et al. define the main purpose of case study as understanding a case or cases in context. Case study approach aims also to interpret and define boundaries of the case. This should be done based on empirical data, the emphasis should be on the case itself, not on the theoretical background. Also, the perspective of the people involved is important for understanding the studied case. Case study focuses on exploring a specific business-related phenomenon through unique real-life cases. Intensive and extensive case study research are sub-categories that are mainly distinguished by the number of cases at hand. An intensive study focuses on a unique case or individual. Extensive case study uses several individuals as instruments instead of focusing on a single case or individual. Extensive case study research is suitable for situation where there is no existing theory, or it has gaps for further research. (Eriksson et al. 2016) There is a need for further research for integration management as Kähkönen (2017) notes. There is only a little current research and literature on application integration management, although the number of system integrations has increased. Most of the literature treat application integrations from the technical perspective or focus on implementing application integrations.

A case study focuses on a current phenomenon in a real-life context. Eskola et al. state that one critical phase of qualitative research is collecting the material in a reasonable manner, which ensures the quality of generalizability. If material collection is done by interviewing, interviewees should be similar, knowledgeable, and motivated. (Eskola et al. 1998) The material for this research was collected via thematic interviews. Research questions and themes concern the operation and management efforts within organizations that are implementing or developing an application integration. Such phenomenon can occur infrequently within a single organization. In order of ensuring the generalizability of the material and the expertise of the interviewees, defining the target group is necessary. Hirsjärvi et al. mention that already few discretionary samples can offer detailed information on a case. Saturation can be used as an indication of a sufficient amount of material, if the researcher takes care of the coverage of the sample. (Hirsjärvi et al. 1995) The perspective of software vendor is selected for two reasons. The researcher has a professional network and connections that can be used to acquire sufficient number

of interviewees. Integration and software consultants and project managers have wide expertise on application integrations between different enterprise information systems and within different organizations. Professionals and employees within organizations that are implementing application integration might have too little experience or one-sided perspective.

Material collection for this research was done by interviewing software consulting professionals in different software providers. Interviews were conducted in a semi-structured way as thematic interviews. Hirsijärvi et al. state that this form of interview can be considered as structured as the themes used in the process are same for every interviewee. These themes and the concepts should be based on previous research and literature. Themes and previous theoretical finding are then processed during the interviews with more specific questions, precise definitions and exact questions should not be included in the interview design. Refining of each theme is done within the conversation by both participants. Pre-interviews help the researcher to test the interview frame and outline the practical execution capability of the design. (Hirsijärvi et al. 1995) Eskola et al. support using pre-interviews as a good way of preparing for the practicalities of the interview situation. Interviews and interviewees may differ, but the interviewer is responsible to ensure that all selected themes are addressed during each interview. (Eskola et al. 1998)

Qualitative research analysis focuses on studying material as a whole. Alasuutari defines qualitative analysis into two phases: reduction of findings and interpretation of results. Research material is always reviewed from specific theoretical-methodological point of view and condensed for highlighting the essential findings to the questions at hand. Reduction continues by combining different observations based on common aspects. Qualitative analysis strives to find examples or proofs of regularity covering all material. Any anomalies could lead to changes in theoretical framework or raising the level of abstraction. (Alasuutari 2011) The second phase of qualitative research is interpretation, which binds new material to previous research and literature. There is a lot of qualitative analysis methods, which are scattered across different disciplines. Eskola et al. (1998) list methods as follows:

- quantitative analysis techniques
- themed design
- typing

- content specification
- discursive methods of analysis
- discussion analysis.

Content analysis is one of the basic methods of analysis. It is suitable for cases where there is no exact theoretical background. Content analysis is reviewed by Tuomi et al. This analysis method is divided into three main categories: data-driven analysis, theory-guided analysis, and theory-based analysis, which are based on the three logics of reasoning: inductive, abductive, and deductive. Material acquisition for data-driven analysis can be done freely or guided by a methodology. Material is analysed and findings are reported in a data-driven way. Process of data-driven content analysis has three phases. First the aim is to reduce the material and remove all irrelevant data. The relevant material is coded for the second phase. Similarities and differences are then searched by clustering the material into categories and subcategories, which are then named descriptively. Clustering is the basis for the structure of the entire research. The last phase of this analysis method is conceptualisation, which seeks to create theoretical concepts. Data is condensed in every phase of the analysis and in the conceptualization phase categories and subcategories are combined as much as possible based on the original material. Results of content analysis are concepts formed in the analysis or categories with descriptions. (Tuomi et al. 2017) There are no exact theories on organizational system integration capability. Frameworks for information system integration implementation and possibly suitable maturity models were studied in order of finding theoretical basis for empirical research.

4.2 Interviews and analysis process

Interviews and analysis aim to study the organizational management efforts in application integration projects and maintaining integrations and the effect of such efforts or lack of them. This phenomenon has not been described in detail in existing literature and there is no precise framework for it. This study focuses on the main research question of main application integration management challenges. Two additional sub questions help to outline the complex phenomenon. Nine interviews in total were conducted for this thesis. First two interviews were pre-interviews that were conducted for ensuring the interview

design and practical details. All interviews were remote interviews due to covid-19 pandemic. Interviews were thematic interviews with three themes. These three themes were delivered to the interviewees in advance. Interviews were recorded and later transcribed into text format. Language of every interview was Finnish. At first the educational background, work experience and current role and responsibilities of each interviewee were charted. All respondents had already gained several years of experience on various software implementation tasks. Interviewees were divided into two subgroups: consultants and managers. Professionals with mostly operational and executional role were categorized as consultants (C). Managers (M) worked as project managers or other roles with emphasis on leading and holistic tasks. Both subgroups had the same interview design, but interviewees coding differs between these two groups. The interviewer had work experience from the role of consultant from the software provider side and as an integration consultant. This made the interviews more conversational rather than structured interviews.

Table 6 Interviews

	Title	Job description (integrations)	Date	Duration
C1	Software integration consultant	Integration implementation projects for a financial software	22.4.2020	38 min
M1	Head of integration team	Integration implementations project coordination and integration development for a financial software	24.4.2020	40 min
C2	Software integration consultant	Integration implementation projects for a financial software	13.5.2020	57 min
C3	Software consultant	ERP consultant, integrations as part of software implementation projects	20.5.2020	52 min
M2	Director	Management of software deliveries to enterprise customers	25.5.2020	41 min
M3	Project and service manager	Customer project delivery of a financial software, integrations as part of software implementation projects	30.5.2020	48 min
M4	Project and service manager	Customer project delivery and development of integration platform solutions	1.6.2020	42 min
C4	Software consultant	ERP consultant, integrations as part of software implementation projects	8.6.2020	63 min
M5	Project manager	Customer project delivery of integrations (multiple technologies)	12.6.2020	54 min

First two themes aimed to map the current environment and the perspective of the interviewees regarding the existing research and literature. Third question tried to find out aspects of integration capability and integration management on the customer side and actions. Themed questions were:

1. What kind of application integration challenges have you encountered in your work? (Millaisia ohjelmistointegraatioiden käyttöönottohaasteita olet kohdannut työssäsi?)
2. What kind of management efforts have you noticed on the customer side in application integration projects? (Millaista johtamista olet huomannut asiakkaan puolella ohjelmistointegraatioiden käyttöönottoprojekteissa?)
3. Have you noticed features of the organization's integration capability in your customers? (Oletko havainnut asiakkailla piirteitä organisaation integraatiokyvykkyydestä?)

Interviewees were asked to consider all three themes through case examples, recent software implementation projects and customer contacts. No precise delineation was made based on the customer, software, or other details. Interviewer made notes during the interview and often the discussion returned to previous themes as the same issues were repeated during the conversation. The interview material was written into Finnish and then the text was thematized based on the three themes: integration challenges, integration management and organizational integration capability. The original written version was retained. Then the material was structured based on these themes and themes were studied separately in order to find possible common features under each theme. This classification was based on the notes made during the interviews and exploration of written interview material. Theme of integration challenges studied the common challenges in integration implementation and development projects, emphasizing the customer perspective. Second theme was integration management and its occurrence within customers actions in projects and in longer customer relationships. Third and final theme was defining aspects of organizational integration capability. Interviewees were asked if such measurable capability could exist and what kind of features would it include.

Transcribed thematic text was processed further by highlighting essential expressions within the text. Some interviewees included some features which belonged mainly to software vendor into the conversation. These remarks were omitted from the analysis in this phase of the analysis. Material was reduced by removing the section which do not

have highlighted points. New, reduced document was saved, and thematic written material was also retained for preserving the traceability and connections to the source material. Themed material was then divided into separate statements which were transferred into table form and simplified expressions were added within every statement. Some statements included more than one expression. Statements were grouped based on the simplified expressions, statements with multiple expression were included into all relevant groups. This clustering was based on the categories formed from the simplified expressions. Categories formed the basis for conceptualization and creation of the main concepts for this study. Material was kept separated into three themes in every phase of the analysis. Main concepts were thereby under three different themes. The concepts of each theme aim to answer a research question according to their theme. These results are presented in the next chapter.

5 RESULTS

5.1 Integration challenges

Integration projects, especially within software implementation projects, were generally considered challenging by every interviewee. Analysis and results consider these challenges which were due to the customers participation. After considering all the integration implementation frameworks presented previously in this study and comparing them with the main concepts of the research material the critical success factor model by Lam was selected as the most suitable for presenting the main finding of integration challenges theme. Three main categories for integration challenges were retrieved from the critical success factor model by Lam: top management support, overall integration strategy and EAI project planning and execution. (Lam 2005) The research material did not contain any direct mentions relating to the first critical success factor group, top management support, themes. **Top management** aspect seemed absent from the integration implementations in practice. Their efforts were mentioned only when project failures were discussed. Most of the integration related activities were carried out by application users or IT personnel and issues were escalated to the top management level only when the project was in deep crisis.

Second category of the model, **overall integration strategy**, had two subcategories, technological and business. **Technology planning** included defining common data standards. Smith et al. also consider data integration as a technical issue in their roadmap. It deals with modelling data, possible translations necessary for exchanging data between applications and the meaning of data. Dealing with data integration issues aims to solve the wider issue that data is often application specific and was not designed for sharing. (Smith et al. 2002) Data and its structure seemed to be in the centre of practical integration work.

The actual integration work starts when you start thinking about how things are reconciled with each other, the different systems. (C3)

Sometimes the problem was not necessarily the difference between the applications or data structures rather than incomplete or obsolete knowledge of the data model or structure. Lam advises organizations to develop an enterprise data model. Such model could offer organizations an overall view on their data in different applications and the

business rules between the data. (Lam 2005) Client's lack of knowledge on the data transferred between application is an implication that such model is missing.

We think about the data to be transferred in the integration at the field level, this one system has these fields, and the other system has other fields. And then we think about how they connect to each other, whether some conversion is needed in between. If there is no one from the customers side who really knows the content of the systems and how they are used in the daily work, they easily turn to us, because it is our system. (C1)

Challenges caused by differences in integration technologies between systems could be avoided by developing an integration architecture, which is located also under the critical success factor of technology planning. This confirms the Lams point of integrations being defined by restrictions and limitations of existing applications rather than creating new solutions. (Lam 2005) Legacy systems are not obstacles for creating a functional integration architecture. All four different integration architectures presented by Lam et al. covered legacy systems. Architectures represent four levels of sophistication. Organizations should strive to utilize the most suitable one, not the most sophisticated one as they all have their pros and cons. (Lam et al. 2007) Existence of legacy systems was mentioned by many interviewees and are still a part of practical integration work.

Old systems are no longer updated and old systems do not support current developments. (M2)

Transition to cloud environment and outsourced services placed their own restrictions on application integrations and to the integration solution alternatives. These issues could be detected early by executing a portfolio and an architecture impact analysis. Gericke et al. refer architecture management as one of the success factors of application integration. It is defined as *the process of systematically planning, measuring, controlling, and adjusting the IS architecture*. (Gericke et al. 2010) Deficiencies in architecture management were generally related to the transition to cloud services or outsourcing of IT services.

Not the integrations per se, but for example, this relates to those challenges of the back-end systems, some of them are not cloud-

capable. If even the integration platforms start to move rapidly into the cloud. Some back-end systems cannot be connected to them as they are made for on-premises environment, and we must do technical tricks and fixes to resolve this. (M4)

Lam (2005) places business process change under the overall integration strategy as implementing an EAI solution **changes business processes** and can cause resistance within an organization. Khoumbati et al. discovered the importance of involving all the stakeholders with the Enterprise Application Integration implementation and making them aware of the changes that the project causes. They found this also as a way of reducing the resistance of change. (Khoumbati et al. 2006) **Resistance of change** was mentioned as a challenge among application users. Managing the change was recognized as an important part of the integration project.

Even at the deployment phase customer wonder: "this is how it works in SAP, why not here." It is a familiar experience that the sooner you start working on the change, the more you get the customer to adopt new ways of doing things, the easier it will be to tackle change. (C4)

The bidirectional relationship of business processes and application integrations emerged as the most significant challenge of integration work in the results. Lam et al. present enterprise integration as a key technical enabler in transforming organizations business processes but consider the lack of understanding of end-to-end business processes as the first risk of an enterprise integration process. Such understanding helps participants to develop an integration solution that meets the organizational business goals. The first phase of EIM, the business process integration, seems to be critical for application integration success. (Lam et al. 2004) Business process integration seemed difficult and sometimes non-existent, and it was not clear whose responsibility it would be. Most of the interviewees agreed that the application integration implementation project participants lacked a comprehensive knowledge on the processes that the integration involved and the purpose on the integration from the organizational perspective. Poor process expertise was often mentioned as the main challenge in integration projects overall progress.

At the first meeting, one will be amazed at how poorly prepared the matter is or whether any thought has been given to the overall process

to which the integration relates. And how that big picture is going to work. You waste a lot of time and are not able define a successful integration if you do not really know what you want to achieve. (C1)

Also, the higher-level understanding of business processes and the overall view could be missing from the project team. Process integration is the highest level of the levels of integration by Lam et al. They state that organizations tend to focus on presentation, data, and application-level integrations, but could also benefit on widening their perspective to the levels of service and process. (Lam et al. 2007) Results show that application integration projects would benefit on better understanding both, the process that the integration involves and the comprehensive overview of all the organization's processes.

And there are often, when talking about integrations, quite big chance of misunderstanding if the meaning of the data transfer is not defined well enough. Maybe another process should be started when a specific set of data is received. (M2)

The target group of this research was professionals working for service providers who were involved in integration work mainly within application implementation projects. This was reflected to the emphasis on project related issues. This emphasis was evident also in the critical success factor model proposed by Lam (2005). From the four main categories under **EAI project planning and execution**, three appeared in the research material. Clear requirements and project scope was mentioned under the **realistic project plans and schedule**. Defining application integration and even its purpose were considered as obstacles of project success by most of the interviewees.

Often the challenge is that the customer cannot tell exactly what they need. They are not able to define their need for the integration. (C3)

The importance of defining the purpose of the integration early on was evident based on the answers. The main restrictions for integrations, information system problems which EAI aims to solve are distribution, heterogeneity, and autonomy. (Hasselbring 2000) These factors set prerequisites for application integration and for the practical integration work.

The better you manage to define what you are about to do, the easier it will be to fulfil it later. (C4)

Next three comments all relate to the issue of ownership and accountability of application integrations mentioned by Craggs (2004). He states that this is due to the fact that these projects overlap both IT and business area of expertise and the efforts of both parties are needed to successfully implement application integrations. **Required skills and expertise** were noted by the respondents in cases where they were minor or partially missing. They recognized that sufficient knowledge did exist within the customer organizations but allocating it correctly especially at the beginning of application integration projects seemed rare. Term “wrong people” was used multiple times by several interviewees.

Often there is wrong people at the first meeting from the customer's side. Starting with wrong participants behalf of the customer. They have either mere technical knowledge or there is just a clerk, who is unable to think of the whole, only of his or her own work. (M1)

This polarity of application integration nature was reflected in the statements of interviewees as they divided organizational knowledge into technical and substance expertise. The need for competence in technical and business domains was equally common among managers and consultants.

In a particularly good situation they have both participants, also somebody who understands technical solutions and guides the decision in line with company's guidelines. In worst case there is only either one. If there is just a technical person who understands how a bit travels but does not understand anything about the overall process. (M5)

Having the right people participating in the project from the beginning helps to define the project responsibilities. Application integration projects include complex decisions and stakeholders from multiple business areas and require both detailed expertise and top management support.

May be so that no one knows to whom it belongs, but when those data transfers are decided, in that meeting, there must be such person who know about those data transfers. (C2)

The importance of vendor competence was thought to have risen in recent years due to an increase in outsourcing and cloud-services. Some consultants thought that having another service provider as a counterparty helped to implement the technical part of the integration.

Cloud computing has the advantage that if the dialogue partner in the project's technical details is the outsourcing partner, then we probably speak the same language and understand what we want to do. (C1)

Shortcomings in the customer's project management appeared in all parts of the project. Inadequate test and rollout planning caused also resourcing issues towards the end of the project. Integration projects as a part of the application implementation project could be part of the reason these problems as the workload often accumulated for the same people.

The customer is always pretty hands full with other chores and busy. It is always a risk of delays for integrations if you do not get the information you need to build and test the integration. (M3)

Poor definition could cause problems still in testing and rollout phases and hinder the entire lifecycle of application integration. Some interviewees were involved in application integration maintenance and support functions, and they stated that the customer's interest in the application integration seemed to end simultaneously with the implementation project. Customer's lack of understanding on the application integration solution could continue throughout the entire project and cause problems even until the hand over phase.

In the testing phase customer does not have enough knowledge of the functionality of the integration, what it should do and what are the necessary requirements. (M5)

Third category from the proposed critical success factors by Lam (2005) was **client involvement, communication, consultation, and training**. All the respondents felt that customers had difficulties in estimating the need for their own contribution and resources for application integration projects. Respondents thought this was due to the rarity of such projects from the organizational perspective. This comment from an application integration consultant summarizes this problem domain:

- - you have to make the customer answer some questions too early in the process, even before they can answer them at all. (C2)

As application integrations are often multi-supplier projects, the challenge of determination of responsibilities includes software vendors and outsourced service provider such as IT service provider. In case of independent participant, the importance of communication and coordination of information transmission is emphasized regarding to inhouse partners.

When you have two different companies (different service providers) between which the data is transferred. Data conversions must be done between those, so who owns it and who does it. That matter is often unclear and undecided. (C3)

The transition to cloud services was seen as a risk of **customer involvements** diminishing. Many interviewees felt that customers are more and more relying on the service providers and their ability to manage customer specific features. Transfer of applications away from on-premises was seen to cause deterioration of customer overall feeling of control.

Perhaps the on-premises products and their technical features is more understandable to that average user than in the cloud services in cases where the average user is involved in designing the integration but has not technical contribution to the system or transfer technology. (C3)

The extent of integration project seemed to come as a surprise to some customers, their resourcing was seen as inadequate, and they fail to allocate sufficient working hours for the project.

It is often very difficult for the client to conceive their own workload in terms of a project. And I do think it can be hard also for others in the organization. You may not be able to realistically think about how much work there will be for those people to participate in such project. (M5)

The article by Ragovsky et al. notices the change derived from the transition to cloud services and the change in the role and expected skills of inhouse IT personnel. The demand for integration, business and soft skills has increased and some of the technical and detailed skills have become obsolete. (Ragovsky et al. 2014) Majority of the answers

suggested that transition of IT skillset is unfinished and some of the new, required skills are yet to be accumulated in majority of organizations.

5.2 Organizational integration capability

Organizational integration capabilities and themes that were found within the interview material are presented and organized based on the organizational maturity indicators proposed by Gericke et al. (2010). Three of the five indicators were present in the answer material: integration expertise, documentation of IT processes and clarity of processes. Two additional themes were discovered and generally discussed within the interviews: project expertise and organizational culture.

Integration expertise was seen as a competence of employees and should have influence on assigning integration tasks and responsibilities within organization. Having such expertise from early on was considered by an interviewee:

After all, the ideal situation is when you start a new integration you work with people who already have the knowledge of both systems at the level that everything goes smoothly. (M1)

Some respondents related the integration expertise to more general level information system expertise. The skills included both, technical and practical process knowledge and were not restricted barely to IT department. General level of IT sophistication was mentioned by an interviewee when asked what skills should be emphasize concerning integration capability in an organization.

Staff competence related to that information systems, practical and technical know-how. (C3)

In the article by Gericke et al. (2010) **documentation of IT processes** was strongly related to the organised way of defining and modelling IT activities. Especially managers related organizational integration capability to the general capability to manage and govern IT functions.

That the company has an information systems strategy at all or some kind of a road map of what is going on and what is planned. That they

have some information system expertise at all, and investments have been made for developing that expertise. (M5)

The linkage between application integrations and business was the most mentioned maturity feature within the respondents. Ability to manage and understand processes was mentioned as the basis for integration capability. Although this seemed obvious to the managers and consultants, they felt that customers had various capabilities for process management.

Understanding the business is the very key. It must guide all action. (M4)

One is to refine your own processes first. (C4)

According to Gericke et al. (2010) the **clarity of responsibilities** helps organizations to coordinate the diversity of goals and ensuring efficient processes from the overall perspective.

The impact of integrations for business, the importance of data and what it is used for. (C1)

Two new indicators of organizational integration capability were discovered when the research material was analysed. First one was **project expertise**.

It does not matter what project model they use as long as they have one. (C3)

Some of the interviewees thought that this project expertise was only a customer feature and did not affiliate the service provider in any way. A manager stated that there would be a conflict of interest whether they would get too much involved in the decision making within the customer organization.

Some kind of project management and administration, project ownership, it has to be there (within the customer). (M3)

Other manager supported this view by stating that it was customers responsibility to lead the project by setting premises for the application integration project.

The customer demands the right things from us. (M4)

Some respondents had an opposite opinion and would consider having a more significant, but temporary role in project management if necessary. They considered a working application integration as a common goal to strive for together with the customer.

Know-how to help the project succeed and help people to do their part in the way that they succeed on their part. (M5)

Organizational culture and the current situation influence a lot to organizations capability to adopt new processes and manage change. Although this feature was seen as variable and uncontrollable, it did have a clear impact on organization capability to develop application integration solutions.

It is about the organizational culture. If customer company is having cooperation negotiations, it affects participants involvement. (M3)

Application integrations have an impact on organizations processes and the practical work of personnel. Such issues should be processed concurrently.

After all, it often is about the cultural change, the cultural change of a company or organization, it is never easy. (M4)

5.3 Integration management

Integration management frameworks for organizations were absent in the literature studied for this thesis. Significant factors of integration management are proposed after studying application integration challenges and organizational features related to application integration capabilities. These factors consist of themes discussed with interviewees. Interviewees were asked to reflect their experience on customers from the ones having strong management ability to those without any noticeable management efforts. Proposed factors are considered as a part of organizations concurrent processes rather than implementation project sub-areas. Integration management factors had three different main categories by their context. First category included the activities related to project work and addressed as part of an integration implementation projects. Second category consisted of answers regarding customer activities on more general level, also within further development work. Third category concerns organizational features that have major implications to integration management.

Table 7 Integration management categories

Main category	Subcategory
Project	Project management
Customer	Performance management
	Skill management
Organization	Framework management
	Management culture

Project management was discussed a lot within interviews. Most of the integration work the interviewees had experience on was gained in integration implementation projects. Integration implementation management and coordination were often referred as a responsibility of a project manager. Interviewees had experience on both end of the scale, small projects without a project organization to long lasting, well-structured ventures. The role of project manager was seen crucial from early on.

The project manager considers relevant participants and contacts the right people directly. That way project manager reduces our extra work. (C2)

The importance of communication in multi-provider projects was noted by many interviewees. Active project management effort strives for better communication between all stakeholders.

There are often many parties involved in making an integration, maybe even four parties. Someone needs to organize the information exchange and tracking. (C3)

The importance of governance was highlighted as the size of the project increased. Customer involvement and active participation helped them to understand and gain knowledge on the application integration iteratively.

Although some things remain unresolved, someone will ensure that they are processed, and it will not all of a sudden come up latest in the production phase. There is a leader who keeps everyone involved in the project, keeps track of unfinished details, and considers current issues in different phases in more detail. (M1)

Integration management features under the **customer** category consist of the processes and activities related to application integration in the customer organization. Application integration ownership is a feature that was mentioned to be missing from the majority of customers. Some interviewees thought this is due to the increase of cloud services and outsourcing IT services. The software provider professionals expected customers still having the main responsibility of managing application integrations in current environment.

When there are multiple suppliers for various systems, they all are managed and instructed by the customer. (M5)

The ownership was more often linked to business decisions rather than technical details. Interviewees agreed that service providers had the expertise on application integrations but did not have enough knowledge on the environment and other applications linked so that they could lead the decision making. Owner of the integration must have enough understanding on both areas. As Bosch et al. (2010) also state, integration governance responsibilities and ownership should cover data, processes, and systems. Customer's ownership of application integration should not be ownership only on integration, it should include wider understanding of integration related issues within the organization, exceeding departmental boundaries.

The most common challenge I see in my own work is that the product owner is missing from the customer side. That is the person who would own it, because it is ultimately a question of us providing services for the customer according to priorities they are setting. We cannot prioritize for them. (M4)

Managing their own **performance** is a customer feature that relates to ownership of application integrations but is separate from the implementation process. Many interviewees mentioned that some customers lack the ability to manage application integrations even they understand the meaning of owning it. This feature related mainly to the ability to understand information management as a whole and manage business processes and data.

It is our responsibility to run it and maintain it, but they own it. In such case, there must also be strong guidance from their side and the customer does not always have the ability to provide it. (M4)

Some respondents felt that customers' ability to perform in software implementation projects has decreased and thought that this was due to IT services distancing from the core of the business and daily operations. This has increased challenges in communication between customer and supplier especially in application integration projects.

In an ideal situation the client describes the background and how they have designed the integration. But unfortunately, it is quite rare, in the worst case they only arrange a meeting without any introductions. (C1)

And when choices should be made on how to proceed, if there is nobody managing the customers side it is hard to find a person to make the choice. It is unclear who has the authority to decide on the matter. (C1)

Application integration related **skills** are diverse. The level of IT skills was mentioned as most important measure of integration skills in large companies. General understanding on technology and making the full use of it meant a lot in organizations of all sizes. One of the managers stated that the higher level of IT competence was not just a requirement for integration capability but a prerequisite for business competitiveness.

Customers' competence requirements for IT and IT architectures in general are growing all the time. That is, when ten years ago the customer hardly needed to know and understand it, today customers have their own IT architects, because the system implementations are so complex. (M2)

Application integration and software implementation projects occurred in long intervals and an interviewee noted that implementation skills and experience was difficult to maintain in the long run. Often the nature of the application integration and other technology has changed, and every project started from a clean slate.

Probably in all the projects the information increases iteratively. (M3)

Identifying and utilizing existing skills in organization was found to be a challenge especially in application integration projects. Some respondents worked with a certain

application with narrow user base. They felt that customer organizations tend to allocate only resources from that domain to integration projects and some essential knowledge was missing.

It is not enough that one person, who knows things, participates, but they should discuss within the company and utilize other people who have the relevant know-how. (M1)

Organizational features of integration management were differentiated from customer features based on the context the respondents discussed them in. In most of the interviews the discussion turned to the things that helped integration professional to anticipate the result of a project in the very beginning. Some interviewees participated already to presales phase and continued with the same customer while still in continuous service and had experience on full lifecycle of an application integration deployment. Organization's ability to operate in an organized and systematic manner was referred for this thesis as **framework management**. As application integration frameworks and maturity models and other information system frameworks existed in many different levels and scales, this ability means the organization's effort and ability to use the solution that works best for them. A project manager stated that sometimes same organizations face the same problems despite changes in the supplier side.

It is always easy to say that a supplier has ruined a project, but quite often customers who have complained about it, it is not necessarily the first or last time this happens to the customer. Quite often, it is also a question of whether the client's own abilities for carrying out such project are not good enough. (M5)

Top management support was referred for example by Bahli et al. (2007), Lam (2017) and Kamal et al. (2013) being one of the most important success factors of application integration implementation. Although top management did participate into integration projects, their impact was found to be lacking.

We had one client where most of the people in the steering group were not taking any stand on the entire project. All the replies came from the operative personnel and, surprisingly, one sales ledger clerk became a key figure for us because management was not interested. (C4)

Using a framework or a methodology for application integration could help organizations and top management to realise the potential of combining business processes and information technology more efficiently. Usage of a reference architecture, for example the ARDIN reference architecture, helps to illustrate the multidimensional nature of enterprise integration. Utilizing an application integration model, such as the REAL model, promotes organizational ability to understand many layers of application integration work. Defining an organization's operations helps clarify the strategic importance of application integrations and provides a good starting point for integration work.

It is noticeable when the customer leads by doing on their own side. Whether it is a project manager or anyone, who has a clear vision of what you want to achieve and in what time frame. That the goal is clear. (M5)

It is often good to have an in-depth look at the whole project. And this is usually done at the beginning. It facilitates the whole project that thorough discussion has taken place. (M1)

Organizational **culture** was seen as indirectly relevant to organizations integration management. None of the interviewees mentioned any dependencies between culture and organization other features.

-- some are very cooperative, and others basically think that they are dealing with the enemy. (C1)

Culture did have an effect to the way other features of integration management were appreciated and implemented.

We have the privilege of seeing vastly different organizations from the private side and the public sector. I have not found any common denominator for where that ability is at its best. It feels like it is case specific and relates to corporate or organizational culture, the way they develop those talents. It varies a lot. (M4)

6 DISCUSSION AND CONCLUSION

6.1 Discussion of the key findings

The motivation for this thesis was to study organizational capability to implement and manage application integrations. This research was done by reviewing existing literature on application integrations, their implementation challenges and managing of application integrations in order of achieving a comprehensive understanding on the phenomenon. The empirical study for this thesis was done for surveying the main current features of application integrations implementation and management. The purpose of this study was to reflect the practical findings and observations with the previous research and highlight ways to enhance organizational application integration capabilities.

Both literature and empirical study indicates that application integrations are complex and multidimensional. They have general and unique features which involve both technical and substance knowledge. Many definitions for integration exist and they differ for example in perspective and context. One way of presenting application integration is the layered approach, which demonstrates well its complexity. Application integrations have only little direct impact on organizations financial success or overall performance. Main benefits of well executed application integrations are operational flexibility and cost savings achieved by raising the level of automation and decreasing the complexity of enterprise information systems. The proliferation of cloud services is an example of the business environment changes where application integrations have a significant role.

Current practical application integration challenges correspond challenges presented by the literature. Despite the rapid technological developments and prevalence of hybrid environments, application integration technics and solutions seemed to have remained unchanged. Many professionals interviewed for this study regarded point-to-point integrations as the main type of application integration. All the interviewees agreed that some or even most of the customers lacked the relevant knowledge or resources for efficient application integration implementations. Customer related challenges were mainly divided under two categories: lack of overall integration strategy and difficulties in project planning and execution.

Five main organizational integration capabilities were referred by respondents. Three of them were present in literature: integration expertise, documentation of IT processes

and clarity of responsibilities. Two new features derived from the research material were project expertise and organizational culture. Integration expertise and project expertise were seen as the main capabilities from the implementation project perspective. These two capabilities were also seen as the most potential aspects to be developed and increased within customer organizations.

There is some previous research on application integration management and governance. More research and frameworks are done focusing on application integration implementation on the project level and the organizational level. Many of these studies have practical and clear recommendations for successful implementation of integrations. Common features for these studies is cooperation between business and technical domains and need for organization-wide efforts and support. Although the literature studied for this thesis was mainly from the beginning of the 2000s, problem domain and findings are still relevant and valid.

The key finding for this thesis is that the challenges identified by earlier application integration implementation research still widely exist in the modern-day application integration management. Many of the previously known barriers were evident within the results of this study. Almost all application integration issues addressed by the interviewees had one or many confluences with theoretical frameworks. This emphasizes the importance and value of systematic management and development of application integrations that should be based on researched knowledge. Aspects of application integration differ by organization size, industry, and many other factors.

Managing application integrations is, like the phenomenon itself, complex and multidimensional. Three integration management categories were derived from the research results. First category differed in nature from the two others. Project management category related tightly to application integration implementation process and contains general project management aspects. Second category, customer, included application integration related functions and factors within an organization. Its two subcategories focused on two application integration features generally mentioned in literature. Performance management covered aspects of application integration ownership and understanding the impact of integrations from business perspective. Skill management indicated the unique nature of application integration domain and the importance of integration expertise and cooperation. Organization category of integration management regarded features that are often defined at a higher level of an organization or are part of a larger whole. Framework management was part of the organizational

strategy. Chosen integration framework must be in line with other frameworks, same as integration architecture must be in line with organizational architecture. Organizational management culture affects application integration especially because integration work involves many different aspects of an organization, and it overlaps departmental and organizational boundaries.

Practical recommendation of this thesis is that organizations would benefit widely by managing application integrations based on the scientific research. As the literature and knowledge exists, consistent and active management effort is needed for implementing them to organizational level. Three main categories and their subcategories can serve as a basis for defining and developing the organizational application integration features. They provide a scalable but simple starting point for managing organizational application integration capability.

6.2 Limitations and further research

The limitations of this study are related to the selected perspective of service provider and narrow sample of interviewees. Limitation to the number of interviews was mainly due to the covid-19 pandemic and the economic instability caused by it. This study could have benefitted from wider perspective with interviews from the customer organizations representatives and managers. Sometimes respondents focused on addressing the software implementation challenges rather than application integration implementation challenges as their role included both tasks. More accurate concentration of application integration consultants and managers could have refined the results precisely to application integration management.

For future research, a more detailed study on the reasons for inadequate implementation of application integration methodologies and frameworks could be done. Although most of the literature are from the ERP-era, their findings are still up to date, as the empirical study showed. Also, the discrepancy between rapid changes in business environment and the lack of development in organizational capability to utilize benefits enabled by effective application integration solutions could be beneficial.

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