SCHOOL OF ECONOMICS AND MANAGEMENT
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Factors Affecting Success in Migration of Legacy Systems to Service-Oriented Architecture (SOA)

Shared Experiences from Five Case Companies

Master thesis, 15 ECTS , Department of Informatics
Submitted: June 2009
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Examiners: Agneta Olerup, Erik Wallin

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Abstract

Background: The term 'legacy systems' refers to existing Information Systems that have been deployed in the past and have been running critical business processes within an enterprise in its current IT architecture. Based on their important role, legacy systems are considered the heart of a company's operating profit and therefore are of significant business value to the company. Therefore IT architects have not neglected the value these existing assets can bring to the adoption of service-oriented architecture and have been studying different methods and factors to migrate the legacy investments into the new architecture and take advantage of their business value. However, not in all cases has the process of migrating legacy systems into SOA been successful. In fact, the level of success in adapting the legacy systems in a company with the new service-oriented architecture is dependant on some *factors* which vary from one legacy infrastructure and series of business processes to another. There is no quick fix to transforming the existing legacy assets which highlights the fact that considering the right factors to reach legacy system migration success in a specific company is of key value. Therefore, we hereby studied the factors influencing success of migrating these legacy investments into SOA in five different companies which include a Large European Bank, SAS, a Large globally-known Company in Sweden, Sandvik AB and a large UK Bank.

Purpose: To study the factors affecting successful migration of legacy systems into SOA in five companies: A Large European Bank, SAS, A Large globally-known Swedish Company, Sandvik AB and a Large UK Bank.

Method: The main adopted research method in this study has been interviews for different case studies. Through separate interviews, critical success factors of migrating legacy systems into SOA have been collected and identified in each case. Finally collected results are analyzed and presented as the recognized factors affecting successful migration of legacy assets into SOA in five different enterprises with their own Information System infrastructures.

Conclusion: In this research, we concluded the success factors found in our case studies through some cross-case analysis. Those factors include potential of legacy systems for being migrated, strategy of migration, SOA governance, the business process of the company, budgeting and resources, legacy architecture, close monitoring, dependence on commercial products, information architecture, testing and technical skills of the personnel. Out of all these factors, only three factors have been applied and mentioned by all the case companies in this study, which are the potential of legacy systems for being migrated into SOA, strategy of migration and SOA Governance.
Key words: SOA, Legacy System, Migration, Successful migration, Success Factors

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We would like to thank all of the interviewees in five companies including Large European Bank, SAS, A Large globally-known Swedish Company, Sandvik AB and Large UK Bank for their valuable input and support for this research study.

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Maulahikmah Galinium & Negar Shahbaz

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1 Introduction

In this chapter, the initial problem area is discovered and explained, which in turn will narrow down to the research question, research purpose and delimitation. Furthermore interested parties and the research structure will be presented as well. This chapter is to provide the readers with an overview of the research study.

1.1 Background

Information Technology grows faster day by day. Keeping up with this technology growth requires an inquisitive and explorative attitude in Information Technology which leads to a constant learning process. This approach is very important for innovation that exists in the Information Technology field. Therefore all aspects in our life including individual or corporate ones have been influenced by Information Technology. Furthermore, technology also plays an important role in a company. A company requires information systems to support its daily working life. Therefore a system's development process is very important to create a new system for the company. There are a lot of methodologies, methods, or architectures which support system development, such as client/server architecture, model-driven, agile software development, etc. However this research will focus on the architecture concept of the system development.

One of the most talked-about technologies in the field of information systems' design and architecture in today's technology world is Service-Oriented Architecture, referred to as SOA. According to Erl (2005), SOA is based on the idea that systems are divided into sub-systems (each handling separate tasks) based on group functionality in the business process of a company and then finally all the functionalities are packaged as an interoperable service. In fact there has been a growing trend towards SOA and its adoption within various enterprises in different scales within the past eight years and of course IT leaders expect to see a bigger increase in SOA adoption based on the promised benefits validated by early adopters.

Like other technologies there are groups of people who support SOA technologies whereas there are also other groups who do not support it. However, what is certain is that no one can deny the enhancement SOA offers in terms of efficiency, reusability, agility and productivity of an enterprise. (Erl, 2007)

SOA, as defined in different resources, is an improved approach towards IT and information systems architecture based on a collection of services which are in communication with each other. A more business-specific definition defines service- oriented architecture as a strategy that implements functions through reusable business services. (IBM Company, n.d.)

The most comprehensive definition of SOA considering both IT and business perspectives defines it as an architectural model that aims to enhance the efficiency, agility, and productivity of an enterprise by positioning services as the primary means through which solution logic is represented in support of the realization of the strategic goals associated with service-oriented computing. (Erl, 2007)

Since SOA adoption will revolutionize an enterprise and its information systems, which are the heart of an enterprise, it is important for both the IT technicians and the business executives to keep an eye on the whole process of adoption and post-adoption phases to study

the technical and business status of the enterprise as the critical process of adoption rolls on. For instance, it is fundamental for the CIOs, enterprise architects and project managers to understand that there are different types of business services. Knowing the typology of business services and implementing them with the right technology allows companies to achieve the benefits of adopting an SOA strategy rather than adding new layers of complexity to their IT infrastructure (IBM Company, n.d.). There have been many examples of SOA implementation failure in big enterprises through the past recent years which can be measured based on lack of some technical and organizational factors. These factors vary based on the type of business goals different enterprises may seek. (Meehan, 2008)

Having that mentioned and also considering the fact that service-oriented architecture is a newly-born approach without a beaten path for the adopters to follow, one can easily realize the need for a close study on the issue of SOA adoption and the factors that can come on an enterprise's way while moving forward towards migrating to this approach.

1.2 Research Problem

For our research study, there are some studies which have discussed migration of legacy systems to SOA. We have consulted those discussions as our references when conducting this study.

Lewis et. al. (2006) have discussed the legacy system itself. They have mentioned the potential to the reuse of legacy systems as components into SOA. This can be done by exposing the legacy system's functionality as services. However there must be an analysis on how to convert the functionality of the current system into SOA. The analysis should consider the specific interactions which are required by the SOA and any changes which are important to be made to the legacy system component. The factor of reusing the legacy system component has been adopted in the real case study by the U.S. Department of Defense (DoD) (Lewis et. al., 2006).

Another research has discussed the strategy of how to migrate legacy systems into SOA. Zhang et. al. (2008) have mentioned a strategy known as the black box strategy which is proposed to export the functionalities of legacy system towards web services using a wrapping methodology suitable to GUI-based legacy systems. Canfora et. al. (2006) have also discussed the wrapping methodology which is used in order to make interactive functionalities of legacy systems accessible as web services. Zhang and Yang (2004) have mentioned another strategy, which is a reengineering approach that is used to restructure legacy system code and to facilitate legacy system code extraction for web service code construction.

Another issue is about the business process of the company which is run by the legacy system. The business process of the company should not be changed drastically by adopting SOA. Actually, the challenge facing most companies is not whether to adopt SOA or not, but about when and how to adopt SOA. Woods and Mattern (2006) have mentioned that there is always a lag between technological vision and the business feasibility. It also takes time to consider the potential of the current system without SOA. However when a new approach such as SOA proves to make a noticeable difference in value, the motivation will arise to change towards adopting the new approach. Smith (2007) has also discussed how to develop a realistic strategy for conducting migration, by considering both the business needs of the organization and the technical content of the organization's legacy system portfolio.

Franzen (2008) has studied the essential factors to succeed with SOA in five case studies. She has mentioned SOA governance as one factor which focuses on communication, principles and standards, central SOA function, leadership, funding and ownership. She has also mentioned reusability as a factor as well. Smith (2007) has also mentioned that SOA governance is important. SOA Governance includes budget, policies, coordination and guidance for SOA infrastructure providers, service providers and application developers.

Since SOA has the potential to offer significant benefits to a company, there is a need to explore more about the architectural issues as well as the business issues associated with this new architecture paradigm. Street and Gomaa (2008) have mentioned that there are many companies in the world which are planning either a migration to SOA or adopting SOA. Some companies have already succeeded while many others have failed in migration to SOA. Reddy et. al. (2008) believes that organizations and companies tend to think about migrating their legacy system into SOA, rather than developing the required systems from scratch. However a company needs to have a deep understanding of its legacy system in order to find out if their legacy system has the potential to be migrated into SOA.

As mentioned earlier, adoption of SOA does not necessarily lead to pure benefit in an enterprise and it can leave negative side-effects and consequences. These negative outcomes can even result in drifting away from the primary business goals or just adding layers of complexity to the current information systems' structure without offering any technical or business benefits.

We will hereby mention some sample problems which have been experienced by some enterprises when opting for SOA adoption without any consideration of the business and technical factors to highlight the importance of the need for a study to be carried out before stepping forward.

One common problem in SOA adoption is that many corporations start the project of adopting SOA based on an IT perspective instead of a business one. Considering the technical aspects of the project, implementations might appear successful at times but the impact of the adoption of the new architecture on the business can not be realized without having been considered right from scratch. Such problems are mostly observed in large corporations with well-established IT departments who try to follow every new technology trend. Not surprisingly lack of business alignment with the SOA migration project is an inevitable outcome of such a weak project planning. The most probable negative outcome of such common mistakes is the growing cost of IT without any return on investment (ROI) for the corporation. (Ang et.al. , 2005)

Having studied some sample failure experiences and trying to generalize the path to successful SOA adoption, one can easily realize the need for a close and careful study for each and every SOA migration and adoption project within the aimed enterprise to clarify the factors which can endanger the success of the whole project as well as the factors which can lead to better business and technical outcome of it.

1.3 Research Question

In general, the process of migrating to SOA can be studied from two different perspectives: one is an IT (technical) perspective and the other is from business perspective. The first will be more focused on the technical issues of the implementation of the information systems of

the corporation in the framework of service-oriented architecture while the second perspective will study the business internal and external factors which might affect the success or failure of the project of adopting SOA in a company and whether the newly implemented technologies align with the corporation's primary business goals and perspectives. We in this research have tried to study both perspectives.

Thus, the research question here is:

"What factors affect success in migration of legacy systems into SOA in a company?"

The term *factors* refers to the important components or steps when conducting migration of legacy systems into SOA which play an important role in the migration's success. As already discussed above, various factors affect success of the migration process of legacy systems into SOA within an enterprise. These factors vary from technical to business-oriented and management factors. Since there is a broad range of factors involved, we studied them separately which will help the study to be carried out with deeper focus on each and every important aspect of an SOA adoption project.

The term *success* refers to the accomplishment of organizational objectives as well as organizational goals specifically through migration of legacy systems into SOA. The term *success factors* has also been used to refer to those factors which can affect and play a role in the success of migrating the legacy systems into SOA.

Furthermore, by the term *legacy system* we mean to refer to the applications using mainframes and client-server application designs. Since this research focuses on the legacy information systems within a company, the enterprise system is discussed and we can consider *SOA* in this research as *the enterprise SOA* which is used by the enterprise applications to participate in support of business process (Woods and Mattern, 2006). These applications include Enterprise Resource Planning (ERP) system, Supply Chain Management (SCM) system, Customer Relationship Management (CRM) system or Supplier Relationship Management (SRM) system. In the legacy architecture, each of the mentioned applications either run separately using different vendors or run together but using the same vendor such as SAP. Woods and Mattern (2006, p.14) have mentioned that when using SOA, one should think about components, reusable parts and reusable services which means that each application, for instance, can be based on its own different platform while all of the different application platforms can easily work together and use each other's services and data.

Finally, the term *migration* refers to the changes needed on the legacy systems to move to SOA. Migration can be either based on using some components of legacy systems or go for a completely new set of systems without any components inherited from the legacy systems. It can also mean that other new components are needed to integrate with the legacy systems.

1.4 Literature Study

Before conducting this research, a literature review was carried out on the SOA related topics in order to gain a deeper understanding and knowledge of the research area. This literature review has been carried out based on the previous research done in the topic of SOA as well as the academic references found in papers, books, online journals and internet resources. We found many related academic articles and research reports searching for very broad keywords such as 'SOA', 'Enterprise SOA' and 'Service-oriented Architecture'. However, after coming to a decision on the research area, we started searching for some more specific keywords such

as 'migration of legacy system to SOA', 'potential of legacy system' and 'strategy of migration process'.

Surveying the literature available on the core topic of SOA helped us update our knowledge on where other researchers have been so far and if we can apply their findings in anyway to our specific topic to study. It also provided us with good background knowledge on the topic and history of SOA. As Glaser (1978 cited in Franzen, 2008) had mentioned, this literature review helped us to first see the area of research interest widely and then enter into specific domains. Based on this review, we determined the final research question and the delimitations to this research study. Previous related researches also helped us shape our outlook in this research topic.

1.5 Purpose

The main purpose of this research study is to discover the factors which affect success in migration of legacy systems to SOA. This study is conducted by sharing some organizations' experiences of migration of their legacy assets into SOA. In compliance with this, the aim of the research is answering the research question mentioned earlier.

This topic has academic relevance because it has knowledge contribution to the information technology field. Beside that, this topic also has practical relevance because it studies five real cases of SOA implementation in five companies. Therefore the target audience for this research study can be researchers from the academic world who are interested in SOA and its adoption process within an enterprise.

From the business perspective, through the path to answer the research question above, we studied the business of five corporations in particular to learn the most about the business objectives of them as well as the business goals which were supposed to be fulfilled through the migration to SOA. The corporations under study were required to have made an effort towards the project of migrating SOA regardless of the final outcome having been failure or success. Both failure and success of the project help us learn more about the effects and defects of the process of adopting SOA in the enterprises under study.

1.6 Delimitation

The delimitation of the research study is not to get into the low level of technical and development process. The research study is bound to focus on the IT architecture technology level as well as the business level. However, the business level is only limited to the business perspective which is related to the technology, such as the companies' business process. Therefore the interviewees are limited to the people who have a technological point of view of the company's legacy system, the process of migration to SOA as well as the business process of the company.

Since it is about the systems in a company, we delimit these systems to the enterprise system. As already mentioned, different corporations with different business outlooks, initiatives and perspectives have started hiring service-oriented architecture in the information systems. Each and every one of these business corporations have their own IT and information systems structures and implementations. Having various IT and business infrastructures, different corporations require different factors affecting success in migration of their legacy systems to SOA. Therefore even if we can recognize all the success factors regarding migration of legacy

systems to SOA within a specific company, we cannot generalize all the recognized factors into one single pattern for all the enterprises with different business objectives compared to the ones under study here. In other words, the discovered factors are generalized based on the five companies' experiences of migrating their legacy systems to SOA concept in this study, thus the recognized factors in this study will not cover all the various organizational situations for migration of legacy system into SOA.

1.7 Interested Parties

This research is aimed to add to the academic material already available on influencing factors in migration of legacy systems to SOA. By identifying the factors which affect success in migration of legacy system to SOA in some companies, other companies might benefit from our findings in both technical and business aspects. Using our findings may help many companies have better planning and strategies to manage the complexity of SOA in migration of legacy systems into SOA. Companies which already have the experience of migrating their legacy systems into SOA can compare their strategies with other companies in order to improve their own systems. Thus the interested parties for this research study range from researchers from the academic world to people from the industry.

1.8 Structure

The structure used in this thesis is based on the classical research approach, which are Introduction, Theoretical Framework, Research Method, Empirical Finding, Analysis & Discussion and Conclusion. (Figure 1.1)

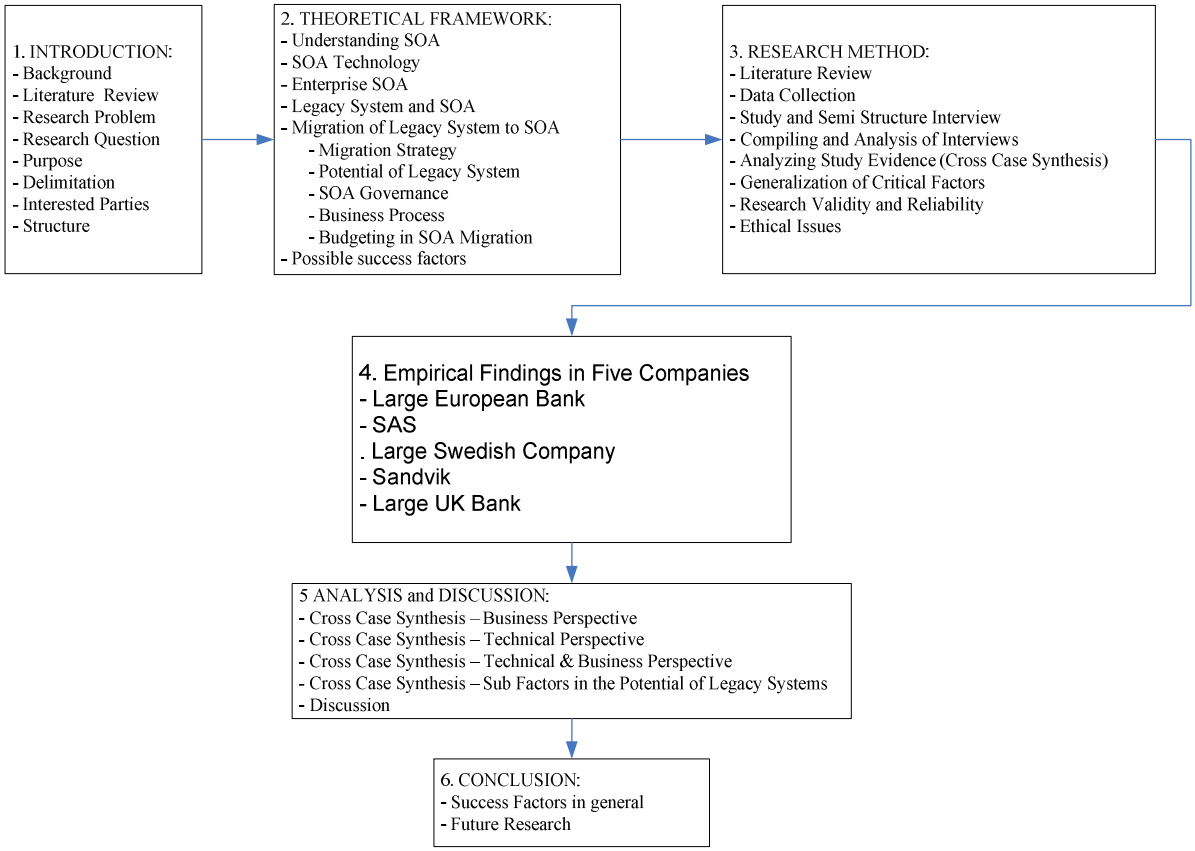

Figure 1.1 Structure of Thesis Report

2 Theoretical Studies

This chapter presents the theories of SOA, legacy systems and their migration into SOA as well as the possible success factors in migration of legacy systems to SOA in an enterprise in order to provide the readers with descriptive knowledge and a deeper understanding of SOA in general as well as the specific area of interest of this research.

2.1 Understanding SOA

One of the most talked-about technologies in the field of information systems' design and architecture in today's technology world is Service-Oriented Architecture, referred to as SOA. In fact there has been a growing trend towards SOA and its adoption in various enterprises in different scales within the past eight years and of course IT leaders expect to see a bigger increase in SOA adoption based on the promised benefits validated by early adopters.

According to Erl (2005), SOA is based on the idea that systems are divided into sub-systems (each handling separate tasks) based on group functionality in the business process of a company and then finally all the functionalities are packaged as an interoperable service. Thus, services encapsulate logic within different contexts such as a business task, a business process, a business entity and so on. In SOA concept, a service can be used by other services or other programs based on its description. Chatarji (2004) has mentioned that business services are offered based on platform and location independence with supporting authentication and authorization at every level. The connectivity and communication to other services are easy and dynamic. It enhances reliability and reduces hardware acquisition costs. It may also provide real time decision-making in a company. Erl (2005, p. 37) has mentioned the following aspects as key regarding SOA and its services: Loose Coupling, Service Contract, Autonomy, Abstraction, Reusability, Composability, Statelessness and Discoverability.

Erl (2005) has also discussed some organizational benefits of SOA. According to him, these benefits are different for companies based on their respective goals and the manner in which SOA concept is applied. This approach can improve interoperability which makes cross application integration into less development effort. SOA can reuse services in order to save in terms of cost and efforts needed for building it. SOA also influences the organization's agility because it can establish a loosely coupled relationship between two enterprise applications. In business perspective, Chatarji (2004) has highlighted that SOA adoption provides the ability to meet customer demands more quickly. It also makes management of business functionality closer to the business units. It also leverages existing investment in technology and reduces reliance on expensive development.

2.2 SOA Technology

Web Services are one of the technologies to implement SOA. According to Lawrence (2007) a web service can be seen as a technology enabling SOA which describes a standardized way to integrate web-based applications using technologies like Extensible Markup Language (XML), Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL) and Universal Description, Discovery and Integration (UDDI). Web services are not tied to any operating system or programming language.

According to Erl (2005), SOA has three basic components (figure 2), which are the service requestor, the service provider and the service registry.

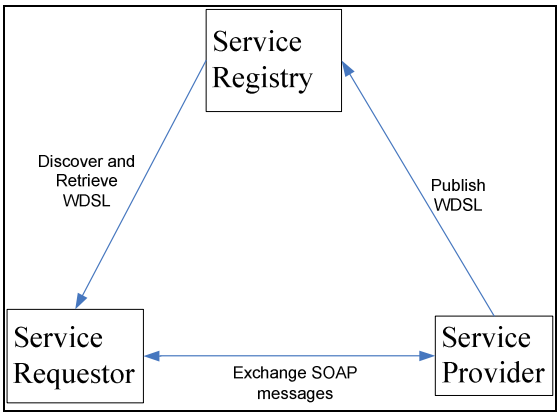

Figure 2.1 An early incarnation of SOA (Erl, 2005, p. 75)

As the figure illustrates, a service provider creates a web service and then publishes its interface and access information to the service registry. Furthermore, a service requester locates entries in the service registry using various find operations and then binds to the service provider in order to invoke one of the web services. Beside that, the service requestor and the service provider exchange SOAP messages. (Erl, 2005)

2.3 Enterprise SOA

This research focuses on the enterprise system which consists of the information systems within a company. Therefore, SOA is considered as *the enterprise SOA,* which according to Woods and Mattern (2006), applies to the entire enterprise applications to participate in support of the business process. Enterprise SOA is built by composite applications based on the principles of SOA. Woods and Mattern (2006, p. 18) believes that there is a process integration logic in enterprise SOA. This process consists of a workflow within an application, process orchestration within a composite application and the logic which is required when a process is handed out from one enterprise application to another.

Moreover, Woods and Mattern (2006) have discussed Enterprise SOA using a basic stack that acts as a unified model for user interfaces, processes and information with clear task description for each layer. Application in enterprise SOA is implemented based on the division of the tasks for each layer.

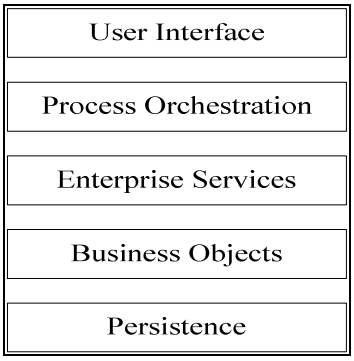

Figure 2.2 Enterprise SOA stack (Woods & Mattern, 2006, p. 19)

User interfaces in SOA are created either through modelling, using patterns as building blocks or both. The purpose of this layer is to reuse the configurable components and adjustable patterns to reduce the complexity of the user interface for enterprise applications. *Process orchestration* is used by composites as the coordinator and integrator of a set of process steps in enterprise application. In this layer, process logic will be separated from all other kinds of logic. The main purposes of this layer is to make process orchestration easier to build and modify in order to make changes to the applications more quickly, cheaply and make them available to many groups of users. (Woods & Mattern, 2006, pp. 19-20)

Enterprise services refer to services that are used by enterprise applications to support the business process in a company. These services live in the enterprise service repository. They store the data that describes the service interfaces, how the services will be used in the development tools and how the services fit into the business process model. *Business objects* are units of modelling or collections of related data and functionality in a service provider. Business objects are also inside composite applications. Enterprise services and business objects are related to each other. Enterprise services expose the functionality of business objects to the outside world. (Woods & Mattern, 2006, pp. 20)

Woods and Mattern (2006) have claimed that this enterprise SOA uses a distributed repository because having a single database is no longer valid in such SOAs. They have also discussed the levels of redundancy which will be handled through aggregation and distribution mechanisms. Furthermore, composite application in enterprise SOA must have their own robust persistence mechanisms in order to maintain the database records when the application stores new information.

Enterprise SOA also needs supporting elements to support the enterprise SOA stack (figure 2.3).

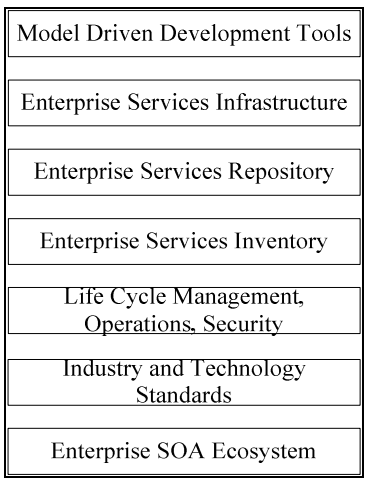

Figure 2.3 Supporting Elements of the Enterprise SOA Stack (Woods & Mattern, 2006, p. 24)

Model driven development tools are used to simplify the application development process and expand the population which can adapt the application. Enterprise service infrastructure is used as an architecture and supporting technology for designing and creating enterprise services. Enterprise service repository is used to create repository to support incorporation of enterprise services in all levels of modelling. Enterprise service inventory is used to comprise the services based on the application designed to support the company's business process. Then it is time to manage issues related to operations, life cycle and security of enterprise services through modelling and standard documentation. This standard is used to reduce

development cost and increase interoperability between services or applications. At last, we also need to create an ecosystem for customers, partners and system integrators which can all use Enterprise SOA as a standard in their business process. (Woods and Mattern, 2006, p. 24)

2.4 Legacy Systems and SOA

Legacy systems are applications which are based on mainframes or client-server application designs, such as ERP system, SCM system, CRM system or SRM system. However in the legacy architecture of a company, each of the mentioned applications either run separately using different vendors or run together but bound to using the same vendor such as SAP. Bisbal et. al. (1999) have mentioned that legacy system is backbone and core of the organization's information flow. Therefore they are very important for a company in order to run their business process to make profit. Their failure can have a serious impact on the business.

When talking about adopting SOA, most companies prefer not to risk replacing the whole legacy by newly developed systems. The reason for this caution is that the business process of the company has already been running through the legacy applications and risking to replace those systems can cause difficulties in the running work routine of the company. Beside that, developing new systems can mean spending huge amounts of time and resources which will burden economical considerations on the company.

Bisbal et.al. (1999) have discussed three approaches for the integration of legacy systems with service-oriented architecture. One is redevelopment which is about rewriting the existing applications to improve them. This approach, as mentioned earlier, can be both very costly and risky. A second approach would be wrapping an existing component in the legacy system into a new and more accessible software component. Another approach Bisbal et. al. (1999) have mentioned is migration and moving of the legacy system to a more flexible environment, while it still keeps its original data and functionality. In our research study, we focus on the third approach which is specifically about migration of legacy systems into SOA. Lewis et. al. (2006) has discussed the potential to reuse the legacy systems as components into SOA. This can be done by exposing the legacy system's functionality as services. However there must be an analysis on how to convert the functionality of the current system into SOA. The analysis should consider the specific interactions which are required by SOA as well as any changes which are important to be made to the legacy system component. They mentioned that the factor of reusing the legacy system component has been adopted in a real case study by the U.S. Department of Defense (DoD).

2.5 Migration of Legacy System to SOA

As mentioned earlier, there are three approaches to make improvements to the legacy systems which are redevelopment, wrapping and migration. Out of these three approaches, we focus on migration and component – wrapping of legacy systems.

However, since the legacy system is considered an old system in contrast to the current technology, Bisbal et. al. (1999) believes that such migration efforts will not be always successful. Legacy systems run on obsolete hardware which is slow, difficult and expensive to maintain. Another challenge would be the legacy software maintenance which can also be expensive due to lack of documentation and understanding of the software. Integrating the legacy systems with other systems is also difficult due to lack of clean interfaces in the legacy

applications. A legacy system is also very difficult to extend and modify. However, Ulrich (n.d. cited in Samuel, n.d) has mentioned that a legacy system is an already proven and reliable system to support the company's business process including its business functionality.

Therefore, there should exist some factors which would affect the migration process of the legacy and can help overcoming the mentioned challenges. In the following sections, we have discussed some possible factors which can play critical roles in the success of this migration. These potential factors are studied from two perspectives in this research which are the technical perspective and the business perspective.

2.5.1. Perspectives

In this research, potential factors along with the discovered factors are studied considering two business and technical perspectives. Technical perspective refers to the factors which are directly related to Information Systems technology and its boundaries in migration of the legacy assets. Business perspective, on the other hand, has the spotlight on the business-oriented aspects of this migration in a company.

In order to be able to consider the two mentioned perspectives above, we have conducted interviews of this study with people coming from a technical background as well as people with a business expertise in the field of our research.

2.5.2. Migration Strategy

Strategy is important in migration of legacy system to SOA either in technical perspective, business perspective or both ways. The strategy of migration can be decided by the companies whether to reuse the legacy assets as components or web services, apply a specific migration method or just leave the legacy aside and hire redevelopment. If a company finds a suitable strategy, it will give more opportunity to gain success in the migration. In developing a migration strategy, we need to identify one or more migration strategi(es) and select the best strategy to achieve the goal of the migration process.

Smith (2007) has mentioned how to develop a realistic strategy for conducting migration, by considering both the business needs of the organization and the technical content of the organization's legacy system portfolio. He has also mentioned the Service-Oriented Migration and Reuse Technique (SMART), which is a technique to initialize the analysis of legacy system components for their potential of being reused as services.

Zhang et. al. (2008) have mentioned that one of the strategies for migration of legacy systems to SOA is the *black box* strategy. It is proposed to export the functionalities of legacy system towards web services using a wrapping methodology suitable to GUI-based legacy systems. This strategy is also used to deploy web services which consist of interaction and inter-communication between user and legacy systems in SOA.

Canfora et. al. (2006) has also discussed the wrapping methodology. They use the wrapping methodology in order to make interactive functionalities of legacy systems accessible as web services. Zhang and Yang (2004) have mentioned another strategy, which is a reengineering approach that applies an improved agglomerative hierarchical clustering algorithm. It is used to restructure legacy system code and to facilitate legacy system code extraction for web service code construction.

2.5.3. Potential of the legacy systems to be integrated with SOA

Before starting the migration, it is necessary to learn about the potential of the legacy systems to be migrated into SOA. This helps with learning about the way the legacy systems can constrain the migration process besides deciding which migration strategy to take up and what components can be reused out of the existing legacy applications.

In describing the existing capabilities of the legacy systems, their potential for migration, the legacy systems' characteristics, their architecture and their code characteristics are studied. In describing the future SOA state, gathering information about the potential services that can be made as components out of the legacy systems would also be necessary. Then the gap between the legacy system and the SOA state must be identified in order to determine the level of effort and cost required for the migration. Then in developing a migration strategy, one or more migration strategi(es) need to be identified and the best strategy is selected to achieve the goal of the migration process.

Furthermore, Lewis et. al. (2006) have also mentioned the characteristics which are used to screen the potential reusable components. These characteristics include size and complexity, level of documentation, scale of changes required, support software required, reusability factors, service abstraction, service discoverability and code quality. *Size and complexity* is used to learn about the size and scales of the legacy systems in terms of the complexity of their architecture. *Level of documentation* is important to learn about different detailed aspects of the legacy assets and can include code documentation, architecture documentation, database documentation, etc.

Scale of changes required is used to know how far we should change the legacy system in order to be migrated into SOA. In the cases of having a lot of changes required in the legacy systems, the degree of difficulty in migration effort will increase. Learning about the *Support software required* for the legacy applications will help with discovering the legacy boundaries and constraints in migration to SOA. *Reusability factor* is used to learn about whether there are components in the legacy systems to be reused in SOA. *Service abstraction* is used to find out whether the legacy system can be easily migrated or not by designing its service abstraction. *Service discoverability* is used to discover the possible existing services in the legacy system in order to be reused as components. *Code quality* is used to know whether the code of the legacy system is easy to be understood and changed in order to integrate that application with new components and migrate it into SOA.

In addition to considering the characteristic or potential of legacy systems, Lewis et. al. (2006) have mentioned other aspects which should be analyzed and considered. The first aspect considers requirements from the potential service users in order to know what applications use the services and how the applications use the services. The second aspect revolves around the technical characteristics of the target environment in SOA, such as the communication protocols, service discovery mechanisms, and so on. The third aspect is the architecture of the legacy system. They mention that it is a critical aspect which can increase or decrease difficulty of the entire migration effort. When doing migration, we should know whether the legacy systems use commercial product or not, whether they are dependent on a specific operating systems or not, and whether the separation of concerns or functions in the systems is of good or poor quality.

The fourth aspect is the efforts involved in writing code in the service interface. The tools to generate the code for receiving requests and producing responds to the legacy system, may not be provided in the legacy environment. Besides writing the code, there is another aspect about translation of data types. The messages in SOA are usually XML documents. The sixth aspect required to be analyzed is the effort to describe the services considering the SOA concepts, including the quality of service (performance, security, reliability). The final aspect urges us to estimate cost, difficulty and risk when doing migration of legacy system into SOA.

2.5.4. SOA Governance

Gil Long, an IBM Distinguished Engineer and SOA governance integration lead defines SOA governance as a careful oversight that was created as an extension to the traditional IT governance with the mission of delivering business value using SOA. From Gil's point of view, SOA governance is to establish a strategic vision for SOA for aligning business and IT visions by providing controls to support this alignment. (Laningham, 2007)

Generally, the process of monitoring and controlling the adoption of SOA as well as the services and applications in the architecture is known as SOA governance. This monitoring is based on some principles and regulations. In other words, it is through SOA governance that decision rights and policies are established for the management of services in SOA. (IBM, n.d.)

According to Woolf (2006), the key goal of SOA governance is the effective management of the lifecycle of service components, services and business processes in different aspects including planning, publishing, discovery, versioning, management, and security. Legal contracts and agreements known as Service-Level agreements (SLAs) are used to define the duties and expectations related to each service provider and consumer. Schneider (2007) added that SOA governance can be seen as an organization that moves SOA forward. It provides guidance regarding SOA infrastructure as well as related documentation. Some of the tasks which SOA governance is responsible for include Program Management, Service Portfolio Management, SOA Infrastructure Architect, SOA Infrastructure Administrator and Service Product Management.

According to Barnes and Anggarwal (2008), three components are known to consist SOA governance including a SOA registry, a SOA policy and a SOA testing procedure. Here is a brief description of each component:

1. SOA Registry: this registry is a catalogue of information on the services implemented in a service-oriented architecture.
2. SOA Policy is a collection of constraints to keep the services consistent with each other. They also guarantee better engineering practices and that customer relations principles and government laws are followed. Occasional policy exceptions can be granted at times.
3. SOA Testing: This is a schedule to ensure the efficiency, security and cost-affectivity of the adopted service-oriented architecture. This schedule consists of procedures to monitor performance of services within the structure.

The need for SOA governance

Woolf (2006) has said that SOA business and technical governance is required as an extension to IT governance, to achieve SOA's promised benefits and a successful SOA.

Furthermore, in a service-oriented architecture, he mentioned that the providers and consumers of the services need to have a lot of successful cooperation with each other. This cooperation cannot be easily achieved without any coordination since the service providers and consumers each run their own processes in different departments. This required coordination is provided by governance.

According to Tews (2008), SOA governance is meant to ensure service quality, consistency, predictability and performance. It also constrains the personnel to follow the governance policies and to correct all the problems in accordance with the governance regulations. Woolf (2006) has mentioned that SOA governance distinguishes responsibilities and establishes agreements among the service providers and consumers on what the consumers can expect or what the providers are expected to provide. This role of governance well defines better service quality, consistency and predictability.

How does SOA governance relate to the legacy systems?

As mentioned earlier, it is through SOA governance that the development of reusable services and their design and change-over-time is defined. Through the guidance of SOA governance, the architect can decide on what services are already available in the legacy systems, whether they are reliable enough or new services are needed to be created, what changes are needed, the need of different customers for the same service, etc. (Woolf, 2006)

Woolf (2006) has mentioned that another key aspect in SOA governance, inherited from IT governance, is code reuse which is the reuse of the legacy code. Although reusable code is considered very good but it is also very difficult to make practical. Issues such as the price for redevelopment, customization and versioning of the old code are guided by SOA governance. Mitra (2005), a senior IBM IT architect, defines the following as SOA governance main areas: strategic alignment, value delivery, risk management, resource management and performance measurement. One of the aspects that value delivery covers is expense reduction. Code reuse and migration of legacy systems as services into SOA can be one way to achieve this goal. Risk management is all about focusing on business continuity and therefore protecting IT (legacy) assets. Resource management also focuses on optimizing infrastructure services and it can also cover development of optimized services out of the existing legacy assets.

SOA governance manages the creation of services to be efficient and accurate in maintaining the logical to physical relationship between them, the physical legacy application and the related data stores. It is in this way that governance manages the migration of legacy systems and its related issues. (Sweeney, 2009)

2.5.5. Business Process

According to Buyens (n.d.), tasks and activities which have been coordinated with each other to run the daily work routine of an organization, either handled by human or equipments, are referred to as the organization's business process. It should be mentioned that these tasks are all expected to provide the path for the organization to achieve its organizational and business goals. These business goals can to some extent be related to the customers of the enterprise.

Smith and Finger (2006 cited in Kotelnikov, n.d.) define business process with its focus on customers and their satisfaction:

"A business process is the complete and dynamically coordinated set of collaborative and transactional activities that deliver value to customers."

Sparks (2000) mentioned that a business process can be defined as a collection of coordinated tasks and activities which are meant to work together to fulfill the organizational aims and goal which could be focused on a specific market or customer. Business processes are all about how the work is handled within an enterprise. They are not about what work is done. A process can be defined as an ordering of activities with a sequence of time and place which has been clearly defined with a beginning, an end and specific inputs and outputs.

According to the definitions above, a business process must pursue a goal. The inputs and outputs of a business process need to be clearly defined and known. The business process relies on the support of resources. It can involve more than one organizational unit and also create value to some external or internal customer. (Sparks, 2000)

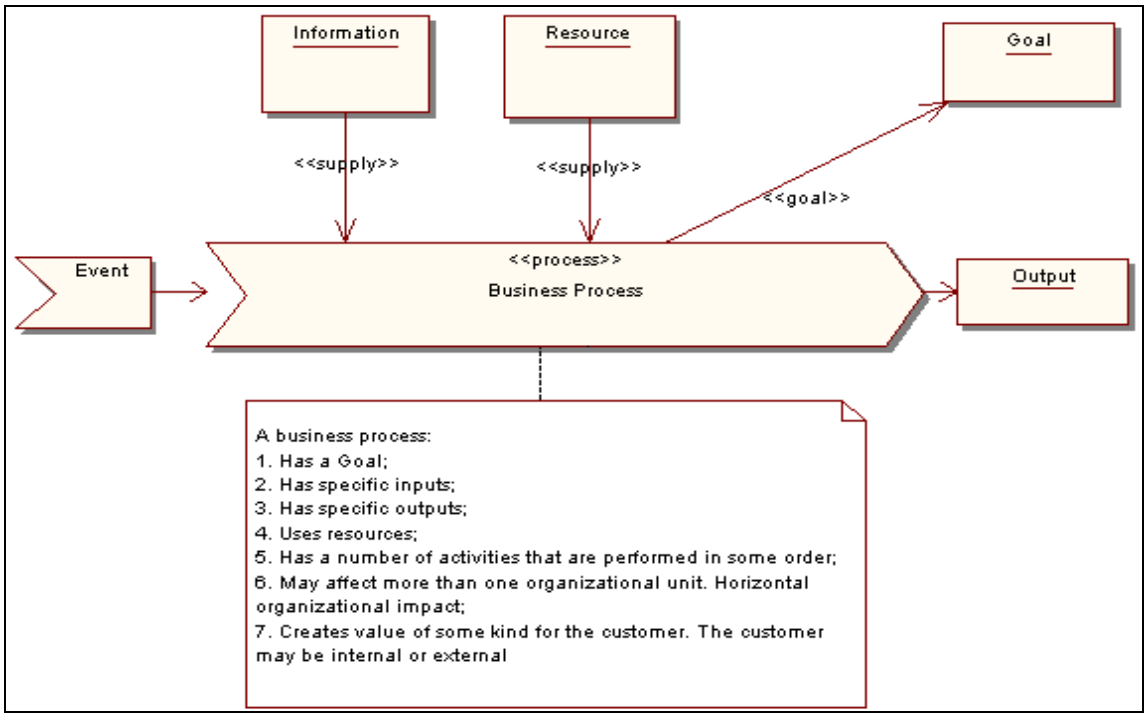

Figure 2.4 Business Process Definition (Sparks, 2000)

Broadbent et. al. (1999) mentioned that information technology and IT infrastructure of a company play an important role in the success of its business process design, implementation and redesign. A basic level of IT infrastructure is required in a company to be able to implement its business process. Having a developed or concurrent IT infrastructure when opting for business process redesign results in a more guaranteed success. The capabilities of information technology can be applied to either design or redesign the business process of the company in an enterprise. The relationship between business process design and information technology capabilities can be seen as recursive. In fact both information technology and business process of a company can support each other and have impacts on each other. Information systems architecture of a company can fundamentally reshape its business process. Considering information systems on the other hand, must be in terms of how they support the business process of the whole enterprise. (Davenport and Short, 1990)

As already mentioned, service-oriented architecture (SOA) is an IT approach which is business-oriented. This approach supports business through linked and repeatable business tasks which are also known as services. In other words, services act as elements in the business process of the company with the duty of implementing the business tasks and activities. These services are invoked in the business process, each responsible to handle one or some of its tasks. When it comes to SOA migration, we are considering a migration from the company's current information systems architecture into a new one which is service-oriented. Therefore it is considered very critical for the newly-adopted architecture to support the business process of the company as well. In fact, the adopted information technology requires to be able to fulfill the business tasks and flow of the business process. (Gimnich, n.d.)

The business process of the company has been running through the legacy systems and this makes the organization very dependant on its legacy infrastructure and information technology systems. In fact, the legacy systems are an important section of the SOA migration process and migration of legacy systems into SOA is one critical issue with many disputes over its success and failure. Migration of legacy systems, also known as legacy enablement, refers to enabling the existing software and information systems to be used in new business processes within the newly-adopted SOA architecture. (Lawrence, 2007)

Much to the architect's surprise, migrating legacy systems into SOA can turn out a very complex task. The organization's business process has usually been implemented through the legacy long time ago the people responsible for such systems may be out of reach now. Lack of sufficient and adequate documentation on the business process implemented in the legacy systems is another problem in their migration. (Maréchaux, 2008)

Having considered the problems mentioned above, it turns out to be very important for the business processes of the enterprise to be studied and compared with the ones already implemented through the legacy systems. This way, SOA architects can recognise the current business processes which have already been implemented and the outdated processes which need to be improved to recreate value out of the existing legacy assets. (Maréchaux, 2008)

2.5.6. Budgeting in SOA Migration

The term 'budget' refers to the enterprise leaders' estimation of organization's income against its expenses for a future period or a particular future project. Budgeting process refers to the process of monitoring and managing the spending of the financial resources all through the life of a project. Budgeting process can be split into two distinct processes of setting the budget and monitoring the budget. (Saudi e-Government Program, 2007)

IT budgeting is considered a critical and decisive factor in every IT project. IT budgeting ensures the availability of sufficient and adequate financial resources for the success and fulfilment of IT projects. It is worth mentioning that IT budgeting is a subtask covered by IT governance, which has already been discussed earlier. (Saudi e-Government Program, 2007)

There exist some key factors which are required to be observed while doing IT budgeting:
The IT team and department need to have a long-term IT strategy. IT budgeting has to be aligned with the company's business requirements in order to be successful. It is also very important to have some performance measures and indicators defined through which budgeting can be more precisely handled based on the true state of the organization. Keeping

track of the pervious budgeting processes can also help in the way of comparing the previous practices results with the current budgeting process. (Saudi e-Government Program, 2007)

Jeff (2007) has mentioned that when it comes to migration to SOA, no one can ignore the important need for careful budgeting. SOA migration can cost huge amounts of funds and can take long periods to complete but it can turn out worth investing on through appropriate funding. Linthicum (2007) has mentioned that SOA budget planning considering the mentioned dimensions to SOA adoption can seriously contribute to the success of adopting and implementing a service-oriented architecture. On the other hand, lack of insight and foresight on the required migration budget can push enterprises towards spending (better to say waste) their money on aspects and areas which are not the right fields to guarantee a long-term success for their SOA.

Jeff (2007) believes that it is not possible to formulate a budgeting plan which can fit every SOA adoption project but he recommends six areas to consider when it comes to investment on SOA:

1. SOA foundation: A process of utilizing internal and external resources, upon which SOA strategy, methodology, reference architecture, standards development and SOA governance are planned.
2. SOA infrastructure realization
3. SOA governance team
4. Enterprise architecture domain analysis: this includes Process Reengineering, Process Modeling, Service Identification, Service Analysis and Composite Application Requirements Gathering in a particular domain (eg. Supply Chain, etc.)
5. SOA training and change management
6. SOA build and integration teams

The role of budgeting in legacy systems migration
Since the focus of this research is on migrating legacy systems in particular into SOA, we will now study the SOA funding and budget factor from the legacy perspective.

Caine and Hardman (2007) believe that when it comes to SOA transformation, it is necessary to balance the potential and capabilities of the legacy systems against the need for SOA as well as the available budget. According to Vaidyanathan (n.d.), migrating legacy systems into SOA contributes to a cost-effective optimization of the enterprise architecture by providing more value for money. This can eventually lead to better performance out of the legacy code while adopting a SOA architecture which is aligned with business needs.

Considering the fact that the legacy systems have been running the business process of the enterprise for several years, a proper strategy towards the legacy transformation can release the company's funds for more innovation and creating a transformational IT department. This is because of some cut downs on legacy expenses when either retiring or migrating the legacy systems. (IBM, 2008)

2.6 Summary: Possible Factors for Migrating Legacy Systems into SOA

Considering the literature review and the previous research carried out in this field, we have come to the following factors as the possible factors affecting a successful migration of legacy systems into SOA:

1. *SOA Migration Strategy*: Before conducting migration, it is necessary to consider the migration strategy either being technical or business-oriented in which companies decide whether to reuse the legacy assets as components or web services or to apply redevelopment.

2. *Potential of Legacy Systems* to be integrated with Service-Oriented Architecture: This is also one technical factor required to be taken into consideration before starting the migration. This is due to the fact that not all the legacy applications have the potential to be integrated and reused as components or services in SOA.

3. *SOA Governance*: SOA Governance can define boundaries and regulations for legacy migration through agreements known as SLAs. SLAs can be technical or business-oriented.

4. *Business Process of the company*: Business Process of a company defines the way its routine tasks are run and it is usually handled by the legacy applications in a company. It can be seen as a business-oriented factor since it is directly related to the way business is run.

5. *Budget Plan of SOA migration*: Budgeting and Resources also play an important role in our findings since migration is a costly process in terms of monetary, human and time resources. This factor lays on the strategic and business-oriented decision making of the company.

The findings above are verified in two business and technical perspectives in this research and have been used to design the interview questions in this research and have been under study in the five cases of this study.

3 Research Method

The research method to apply for this research study has been interviews for multiple experience studies. In this section, this study's research method will be presented and motivated in detail in order to explain how the data has been collected and analysed.

In this research, we applied a collection of research methods to fulfill the main purpose of the study. Our adopted methodologies include literature review, multiple-experience studies through qualitative interviews, cross-case analysis (synthesis) of the discovered factors through the case studies and finally generalization. A visual overview of the research method for this research study is presented in the following figure.

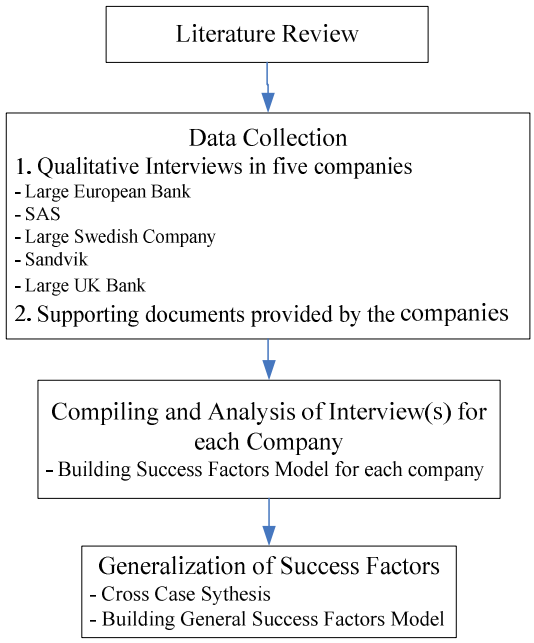

Figure 3.1 Methodology

3.1 Data Collection

As we mentioned earlier, this research study is a descriptive research because the research question "What factors affect success in migration of legacy systems into SOA in a company?" is a "what" question. As Key (1997) has mentioned, such research can be carried out by conducting interviews in order to investigate the relationship between variables. In our study, we have assumed that the variables are the factors which affect success in migration of legacy systems into SOA. To learn more about those factors, we carried out a literature review by reading articles, journals and books related to our topic. As a result of this review, we found some potential factors which could be the ones that we were looking for. These findings included: potential of legacy systems to be migrated into SOA, the strategy of migration, SOA Governance, the business process of the company, and the budget of conducting a migration to SOA. Beside that, we studied the real-life factors in the companies whom we have interviewed.

In this research, we as the investigators are required to have some knowledge and social skills to prepare good-quality questions and also to be able to interpret the answers in an unbiased way.

We also considered the case study protocol which contains its own instruments, procedures and general rules to be followed. Having a case study protocol has been particularly essential for this research since multiple case studies were carried out in some different companies and this protocol could increase the reliability of our case study research. Our research study protocol (see Appendix) includes an overview of the case study project, field procedures, case study questions and a guide for the case study report. We did not carry out a pilot study. However, we received some consultation from our supervisor as well as other experts who had sufficient knowledge on our research area.

As mentioned earlier, we used interviews to conduct this research in order to investigate more clearly the factors which affected success in migration of legacy system to SOA in the target companies. In this research, we aimed to interview the company's business and technical members who had been involved in the project's leading team. Such detailed interviews can provide a close perspective on the real-life factors leading migration of legacy systems to SOA whether succeed or fail in the company under study. From the business perspective, through the path to answer the research question above, we needed to study the business of a corporation in particular to learn the most about the business objectives of the company as well as the business goals which were to be achieved through the migration to SOA. The corporation under study was required to have made an effort towards migrating to SOA regardless of the final outcome having been failure or success. Both failure and success of the project helped us learn more about the effects and defects of the process of adopting SOA in the enterprises under study.

In general, we came to the final decision of applying two different methods to conduct our interviews based on the situation of our thesis research in terms of time, cost and location limitations. We conducted four of our interviews by phone since our interviewees were out of reach in terms of their geographical locations considering our research study region: the city of Lund in Sweden. The main drawback of phone interviews was that we as the interviewers were not able to directly see and read the facial expressions and the body language of the interviewee which were sources of information as well. We had one face to face interview with a company which was geographically reachable. This interview took longer than the interviews carried out on the phone. Therefore we as the interviewers had better chances to explore for more detailed information about the interviewee's experience when conducting a migration to SOA. The face to face interview took around 100 minutes while the interviews carried out on the phone took between 50 to 75 minutes.

Furthermore, conducting an interview requires some physical tools such as a voice recorder to record the conversation, some computer tools to recode or transcribe the interview result and also paper to take notes of important answers. Before conducting the interview, we were careful to consider the ethics of interviewing such as seeking for the interviewer's consent to publish their replies as well as informing them of confidentiality and consequence terms (Kvale, 1996).

3.2 Semi- Structured Interviews

We chose the Interview method for our research in order to closely investigate the factors in each of the companies that we reached for. Using such a method helped us learn about the practical experience of migrating legacy systems in those companies. Our research topic required knowledge from individuals who have been involved in migration of legacy system to SOA at a company as well as group knowledge about the organizational systems. In our

research study, we have not explored in detail *how* and *why* those factors affect success in migration of legacy systems to SOA in the companies under study. However we described and analysed the factors by sharing the experiences of the companies we conducted the interviews with.

In this study, there exist five components of a research design, which are the study's question, its propositions, its unit of analysis, the logic linking the data to the propositions and the criteria for interpreting the findings. We have applied a descriptive research to answer a 'what' question to describe factors which affect migration of legacy system to SOA. Furthermore, we should pay attention to the proposition of the study which should be within its scope. We have discussed in detail earlier in section 1.5, the delimitations of this research. Then we had to consider how to link the data we found in an interview with the proposition of the research study. In our research study, we found the factors in each company after doing the interviews. Afterwards those interpreted factors were used to answer our research question.

In a study similar to our research, some theories are required to be considered including individual theories, group theories, organizational theories and social theories (Yin, 2003). In this study, we have considered the first three theories in order to get complete knowledge about the research topic. The reason for applying individual theories has been to use interviewees' ideas or reflections on the topic. The reason for applying group theories is based on using the previous research studies' findings while the organizational theories are based on interviewees' opinions about the strategy adopted by the company in order to migrate from its legacy systems to SOA. Social theories are not considered in this research since they focus on the impact of SOA adoption in an organization either on its business objectives or on the social environment of the organization which is outside of our research scope.

In this research, we needed to design how to conduct the study. This design is the logic that links the data and the conclusion to the initial research question. This research design includes the process of collecting, analyzing and interpreting observations. It deals with at least four issues, which include: what question to study, what data are relevant, what data to collect and how to analyze the results. The design is used to help to avoid the situation in which the evidence does not address the initial research questions. We have considered all those four problems.

There exist six sources of evidence to refer to, which are documentation, archival records, interviews, direct observations, participant observation and physical artefacts (Yin, 2003). We used interviews and companies' supporting documentation as our sources of evidence in our analysis. We got some supporting documentation from some of the companies under study in order to have better knowledge about their SOA adoption. The reason for using the supporting documentation is due to its stability and that it can be reviewed repeatedly with unobtrusive, exact, and broad coverage. Interviews were chosen because they could be focused directly on this study's topic.

3.3 Interviews and Related Questions

In our research study, we want to gain knowledge about migration of legacy system to SOA from some institutions which have already had the required experience. Therefore, we have opted for using the interview method. There exist seven methodological stages as practical guidelines to conduct research interviews. These stages include thematizing, designing,

interviewing, transcribing, analyzing, verifying and reporting (Kvale, 1996). The following figure is the process in which we conducted the interviews.

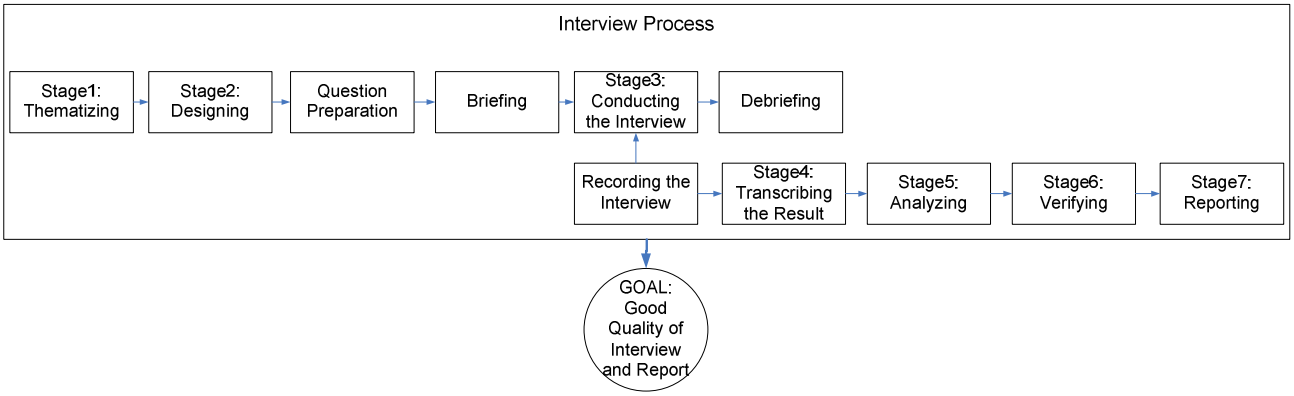

Figure 3.2 Interview Process

In our interview process, we went through Kvale's seven methodological stages. Initially we did thematizing, which means the interview topic is based on our research topic to find out what factors affect migration of legacy systems to SOA in a company. In this stage, the content and purpose of the interview are clearly stated and clarified. Then in the second stage which is about designing, we planed the overall planning and preparation of the procedure to conduct the interview, including planning for the questions, how to transcribe the result, how to analyze and verify the result and how to write the report. After we had a strong design, we continued to conduct the interview. When conducting an interview, briefing and debriefing is considered very important. Briefing must be conducted before the main interview. It is used to explain the purpose and the context of the interview in order to make the interviewee understand the research study and its purpose. Debriefing must be conducted before the ending of the interview. In this phase, we asked the interviewee whether there was anything else left to say and also about the interviewee's experience of the interview which they just did.(Kvale, 1996)

When planning the interview questions, we considered two major themes which were the technical theme and the business-oriented theme. The reason for this separation was that we had planned to study the affecting factors from both technical and organizational perspectives. Therefore we placed the questions about potential of the legacy systems to be migrated into SOA, feasibility of components, architecture of the legacy systems, legacy's dependence on commercial products, quality of service, technical risks and maintenance, governance and the strategy of migration in the technical category while we had some questions about the company's business process and budgeting plan in the business category. We also considered a third and more general group of questions through which we enquired about the general monitoring and testing of the SOA adoption trend inside the company as well as the general challenges which could come on their way when carrying out the integration with legacy systems.

When conducting our interviews, we recorded them in order to make their analysis easier and also to focus on listening to the interviewee with a free mind to avoid having the worries of writing every word the interviewee said. In the fourth stage, we transcribed the interview results into a written script. The transcription result is an abstraction of the original interview. For maintaining the reliability of the interview result, both of us transcribed each interview in order to minimize the chances of possible error. In the 5th stage, after transcribing the results,

we did some analysis, which has been explained in detail in section 3.4. Then in the 6th stage, we verified our finding by measuring the reliability and validity of our findings. This part is explained in detail in section 3.6.

We collected the data from relevant companies which have been or still are involved in migration of legacy systems to SOA. Those data is then compiled and analysed individually for each company. After the companies' separate analysis of their findings, we carried out a cross-case analysis and then finally we generalized our findings into possible factors which can affect the success in migration of legacy systems to SOA.

3.4 Compiling and Analysis of Interviews

Before doing any analysis on the interview results, we needed to transcribe the interview results. The transcriptions are an abstraction of the original interview. In the transcription process, each of us did a separate transcription in order to maintain the reliability of the transcription. Transcriptions were made based on the specific sections of the interviews which really answered the questions regardless of the peripheral and excess explanations on topics not related to our research. In other words, we did not transcribe the interviews verbatim and word by word. It is difficult to measure the validity of the transcriptions since there does not exist an exactly correct transcription.

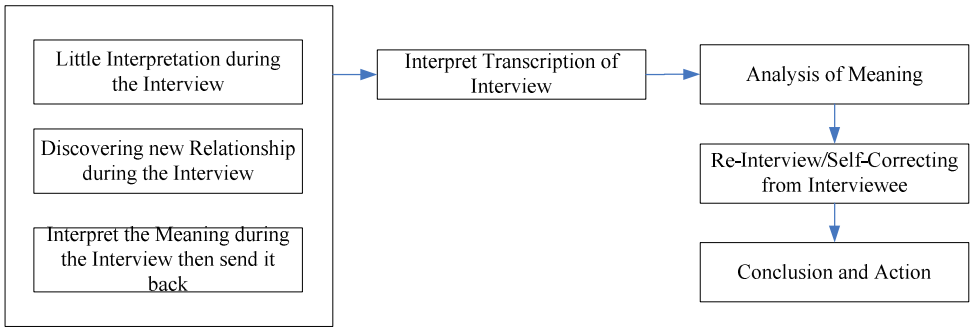

Figure 3.3 Interview Analysis Process

We did the analysis of our interviews based on Kvale (1996, pp.189-190) steps as you can see in the above figure. During the interview, we took note of some of our interpretations directly and then we later sent them back to the interviewee in order to discover further information. This means that the conversation is in two directions between the interviewee and us as the interviewers. Beside that, during the interview, we discovered the new relationships about what the interviewees described based on their experience.

One important issue to have on mind when dealing with transcriptions is the need for an analysis of meaning. Out of all of the possible main approaches (condensation, categorization, narrative structuring, interpretation, ad hoc methods), we used the ad hoc method to interpret and analyze our research study. The reason for using the ad hoc method is that it uses different approaches and techniques for meaning generation. Therefore there is no standard method in this ad hoc method. Thus this method is rather flexible and free of playing any particular technique during the analysis (Kvale, 1996). In our analysis we used the descriptive style to describe the factors based on each company's experience.

Furthermore, we sent our analysis results to the interviewees in order to verify and validate our analysis. We decided to represent the main findings of each company in a separate overview chapter for each interview. We chose this structure for our work since it would provide a clear and well-structured overview of each company's migration experience findings regardless of the results of the other companies. We did this to avoid a re-interview. Then in the end, we concluded the factors in general based on the five companies that we had through a cross-case analysis (Yin, 2003). We also made the visualization of our conclusions about the factors in diagrams known as word tables[1].

After the cross-case analysis chapter, we decided to open a new chapter as the final chapter to include our general conclusion of the entire study using the generalization method. We have tried to present and discuss the overall implications of the results of all the companies in this chapter using Kvale and Brinkmann (2008)'s guidelines. We have also motivated the relevance of the findings to the original research question as well as the relevance of the practically discovered factors with the theoretical findings in the literature review.

3.5 Analyzing the Evidence from Five Companies (Cross-Case Synthesis)

In this research, we decided to take up the theoretical propositions strategy[2] due to the fact that several parameters already existed regarding a SOA adoption process even though they were not explicitly mentioned as success factors in the literature. After deciding on the research question, we carried out a literature review to get some clue about the possible factors in a company which could be effective on integration of the legacy systems with SOA. Then, we investigated if those possible factors fitted the companies through our interviews. In this investigation, other specific factors were discovered in each company's empirical findings which we had to consider beside our findings of the literature review.

We used cross case synthesis as the chosen analytical technique in our analysis because by using this technique we aggregated our findings across a series of individual studies. Two word tables have been used as tools to draw cross case conclusions about the findings in all the five studies in this research. In the first table, we collected all the discovered factors in separate technical and business-oriented themes. We also considered a shared area between the two perspectives which could cover factors such as strategy of migration which can belong to both themes. Each company's results were entered in the table. The second word table displays the subfactors affecting the potential of legacy systems with the results of each individual company under study. Using those two word tables, we came to some common factors in all of the five companies.

3.6 Generalization of Success Factors

Green and Glasgow (2006) defined generalisation as "the applicability of evidence to situations and populations other than those in which the evidence was produced." In detail, generalization is all about a bottom-up study with its results being judged in terms of relevance and their external validity at large, without reference to any specific situation. This fact required us as the researchers to assess the generalizability of our findings. This means that the findings of our research had to have the factor of external validity to be able to be generalized and result in better use of those findings (Fergusen, 2004). To support generalization, Seale (1999) believes that replication of studies is designed to establish corroborating evidence for findings whose truth status is in doubt.

1. Word table is a table that displays the collected data from the individual cases according to some uniform framework (Yin, 2003, p. 134)
2. Theoretical propositions strategy is a strategy which is based on propositions, which in turn reflect a set of research questions, review of the literature and new hypotheses or propositions (Yin, 2003, p.112)

In this respect, we as the researchers were supposed to distinguish between conclusions which are specific to a study, and broader generalizations. Using this method and being able to generalize the research findings in the conclusion requires an adequate level of understanding.

Therefore we realized that this research needed to be carried out in a more intensive and deeper way to provide a good level of understanding on our research topic. That has been the reason for deciding to study five different companies with their own different settings and architecture backgrounds (Crooks, 1982).

We decided not to use any quantitative methods which were based on hypothesis testing. This decision was based on the fact that in generalization, hypothesis testing can be put aside and the researchers need to focus on description, exploratory data analysis, estimation of the magnitude of effects and replication of interesting findings. Of course we had some initial estimates of the factors we were looking for in research area after the primary literature review section of our thesis work. The reason for this was, according to Crooks (1982), the need for extensive prior investigation to identify the key variables in our research area. However, we also tried to avoid the interference of our literature knowledge with the results we found in reality in any of the companies' interviews so that the real and unbiased results would be produced.

Of course it is necessary to consider the fact that in qualitative research, there can not be any statistical representation which makes generalization to a large population very difficult to evaluate. Therefore, the objective of such qualitative research can be considered as 'theoretical generalization'. In this context, generalization will only apply if the interpretations, standard and criteria of the validity of the results are stated and defined as the specific criteria apart from the criteria of the qualitative research methodology (Annon., 2007). Seale (1999) refers to this concept as transferability which is achieved by providing a detailed and rich description of the setting studied.

Having considered the facts above, Mayring (2007) recommends us as qualitative researchers to think of a good strategy for selecting our companies in a research with generalization purposes which requires a good definition for those selected company to be used in the research. Here is the definition for appropriate cases to be studied in our research work: A selected company in our research is required to be a company or an enterprise which has already experienced a SOA adoption including migrating the legacy assets into the service-oriented architecture. The people to be interviewed for each selected company are supposed to be system architects and decision makers in projects of migration to SOA.

We, in this research, studied five experiences of migration in five different companies in this context. This has been due to the fact that widening the case basis by working with at least three to ten single cases makes it possible to come to more general conclusions (Mayring, 2007). We took up a strategy known as theoretical sampling which is an argumentative generalization in the process of data collection. Using this strategy, we stated the data analysis from the very beginning and then based on the results of the analysis, we decided if any further interviews or documents were needed to support or critical check the initial results iteratively until sufficient evidence was found.

Apart from that, we have integrated the results of the multiple studies of companies to achieve more confident and general results. As a final generalization strategy, we went for comparative literature analysis in which we searched for similar studies to compare our

research achievements with their results and come to more secure generalized conclusions about the main factors affecting successful migration of legacy systems into SOA.

3.7 Research Validity and Reliability

The quality of research design is another important aspect of research which must be considered. Quality is related to trustworthiness, credibility, confirmation ability and data dependability. There are four conditions which are related to design quality in a case study, including construct validity, internal validity, external validity, and reliability (Yin, 2003). In the construct validity, we analyzed the results of the separate studies based on the theory of migration of legacy systems to SOA to see if the results were reasonable according to our early studies. In this case, the internal validity is based on each study. Furthermore in external validity, we established the domain to which a study's findings can be generalized. Before publishing this thesis essay, we validated our analysis by checking it with the interviewees.

In this study, we used multiple-case design because we used five companies as our different cases so that we could compare the success factors in them. We also measured the reliability of our interview transcriptions by comparing two versions of transcriptions which were made by both of us. Then reliability verification is used to measure how consistent the operations of one study were with the same results (Yin, 2003).

In our research study, we did five separate studies so that we could combine the multiple sources of evidence to analyse the result which is one of the three principles[3] which help to deal with the problems of establishing the construct validity and reliability of the study's evidence.

3.8 Ethical Issues

Ethics is one of the important aspects when we conduct the research study. Ethics are supposed to be considered in a research because ethical behaviour can help to protect individuals, community and environment. Ethics are also used to ensure the research integrity, how much the researcher is being honest and follows strong moral principles. It is very important to obey the ethical rules when conducting a research. Since our research is planned to be a collection of several studies using the interview method, we have to bear the heavy responsibility of watching the ethical aspects to the interviews both in conducting and reporting the interviews.

In this research study, we tried to consider all the three main catagories of ethics which are meta-ethics, normative ethics and applied ethics (Israel and Hay, 2006). Meta-ethics is concerned with analysis of moral concepts, exploring the meaning, function, nature and justification of normative judgements, and how ethical evaluations are made. Normative ethics guide the researchers what one should or should not do, in particular situations. It provides the frameworks which allow us to judge people's actions as right or wrong, good or bad. Applied ethics involves how normative ethical theory can be applied in particular issues or situations. The reason for applying all the three types has been the fact that we interacted not only with some employees but also with the companies and the environment surrounding them when investigating the research area.

3. There are three principles for establishing the construct validity and reliability of the case study evidence are: 1.Using multiple sources of evidence by combining them. 2. Creating the case study database. 3. Maintaining a chain of evidence (Yin, 2003, pp 97-106)

Regarding the ethical situation in this research, we needed to consider issues like informed consent, confidentiality and the potential consequences of involvement in the research study. The information in informed consent includes the purpose, methods, demands, risks, inconveniences, discomforts and possible outcomes of the research. Then the respondents or participants of the research study needed to agree to take part in the research after being fully informed. According to Kvale and Brinkmann (2008), it is very important to inform the interviewees of the later use and publication of the interview they are taking part in. We watched this important ethical issue by letting our interviewees find out about our purpose of study beside the later audience and publication of this thesis work in our initial contacts with them either through emails or phone calls. We also re-mentioned the main purpose of the interview and its publication at the beginning of each interview but we did not sign any written agreements on that. Contracts can also be used as agreements between the researchers and the participants. However we did not use contracts as agreements, we only used email agreements by the interviewee.

In this research study, we decided to inform all the participants of the kind of information required before conducting the interview about the topic by asking for their consent from the very beginning of the research study correspondence. We even sent some of the companies confirmation letters which provided information that we were really master students in Lund University who are doing in the master thesis as a proof of our authentication as Lund university students.

Considering the interview ethics, we were very careful with watching interviewees' privacy. All of this study's interviewees were willing to take responsibility for their statements by having their real names mentioned on them. Three of them including the interviewees from the large European bank, the globally-known Swedish company and the large UK bank were not willing to have their company names revealed. In the case of the large European bank, to keep the bank disguised, we did not try to add any false nationality to it since according to Kvale and Brinkmann (2008), we needed to avoid changing the social situations and identity of the company. Therefore we decided to refer to the bank with the general term of 'a large European bank'. We also discussed the confidentiality issues with the companies because there could be some confidential data which were not supposed to be published, such as the business process or the budgeting plan of the company. They should be fully aware of the research purposes of this study and that this research study will be used to assist other companies or other researchers to explore more detail about such topics.

Another example about ethical issues would be briefing and debriefing during the interview. In briefing before conducting the interview, we explained the purpose and the context of the interview to the interviewee in order to provide them with a full understanding about the research study (Kvale, 1996). In debriefing before ending the interview, we asked the interviewees to share whatever they thought was necessary to be mentioned and we also asked for their opinion on the quality of the interview as well as the interview questions.

Regarding the consequences to our research work, the interviewees should consider that our work is aimed at the academic audience. Therefore, their statements can possibly be referenced in other academic studies by other students. This will definitely require the people aimed to participate in our interviews to consider the possible consequences of contributing to an academic study. We made an effort to send a copy of the final interpretation of each interview to its participants before their publication to ask for their opinions and also to check and correct any mis-interpretation or bias.

4 Empirical Finding in Five Companies

This section represents the empirical material as the result of conducted interviews in five different companies including a large European bank, SAS, a Large globally-known Swedish Company, Sandvik and a large UK bank. The analysis and discussion for each company is included in detail as well. The companies and their representatives in the interviews are introduced briefly in order to motivate their suitability for this research.

4.1 Large European Bank

Interview Method: Phone Interview and Email
Date of Interview: 17th April 2009

4.1.1 Company Overview

This SOA adoption study has its focus on the experience of an international bank in Europe with service-oriented architecture and the way they have handled the issue of integration and migration of their legacy assets with the new SOA architecture. Since the interviewee asked for the company's name to be kept undisclosed, we will refer to it as 'a large European bank'.

According to our interviewee from the company, this bank had a very different line of business, including retail banking and investment banking both of which had already gone through extreme renovation. This bank started its SOA experience in 2000 by adopting a proprietary SOA with the bank's own protocols and then carried on with the experience by redefining their infrastructure and starting with application development in 2002.

The main benefits of SOA which this company was trying to attain were flexibility, faster time to market and reusability of the services. They did not want to have IT as a barrier on their way towards introducing new services or improving their current services. Speed of providing new functions was also another factor they were looking for. Considering the fact that their SOA adoption has been very successful, they can introduce new services to the market in as little time as only 3 days now. It is good to mention that a major part of this speed improvement is due to each function being implemented only once which means a high level of reusability of the existing services.

We chose this bank as a selected company to be studied simply because it has had a successful experience of SOA. Therefore it is a proper company to acquire knowledge from about the factors which can affect success in migration of legacy system to SOA in a company.

4.1.2 SOA Adoption

It is good to mention that the initial decision at the bank was not to adopt SOA, the decision was to pick a new core banking system in which each function was only implemented once. Therefore it was initially a component strategy to increase reusability. It has been through the reusability factor that each function can be developed only once and then used by many applications and users over and over again which leads to higher speed in providing services and marketing IT functions. It was in the next phase that in order to make this function available to the whole enterprise, they needed some service architecture. This component

strategy could provide them with speed to market new products and have the IT systems support it. This was the driving force for this new banking system.

The interviewee stated that the bank's largest SOA implementation started in the year 2000 and by 2001, all the transport protocols had been described. To be more specific, they first had a proprietary SOA with their own transport protocols in XML, and then the infrastructure was defined until 2002. By the year 2002 their first application had been written being supported by that SOA infrastructure.

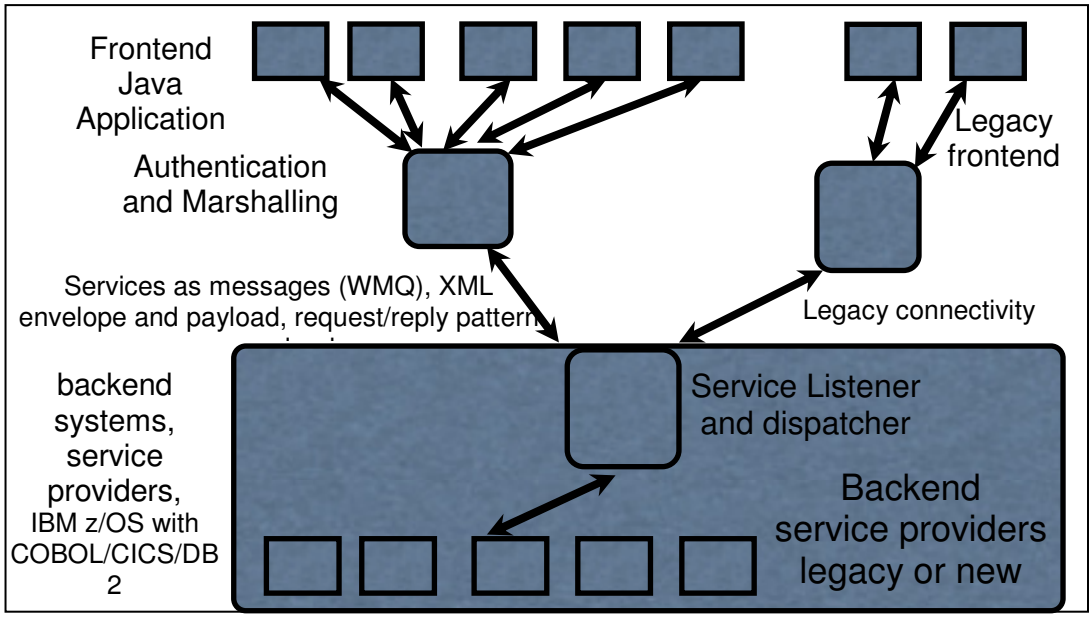

Figure 4.1 SOA Environment in the Large European Bank (By Interviewee)

The environment for the system in this study is shown in figure 4.1. The front-end application uses Java application while the legacy system is still using the legacy front-end. From the interface, the users send the messages. Then the messages will be authenticated and organized by the system. After that, the messages, which are usually XML, are sent to the backend of the system or the service provider. For connection with the backend systems, the system requires service listener and dispatcher. As for the backend service provider, the company used IBM z/OS with COBOL/CICS/DB2 technology.

The Map multi-channel access protocol is the new core banking system in which each function is implemented only once. Regarding the bank's approach towards the legacy systems and their migration into SOA, the interviewee mentioned that the approach had initially been to create a new banking system based on completely newly- developed code but at the beginning of the project, the company service-wrapped all the legacy systems. That meant that all the legacy applications were still parts of the service transport protocol. There is a service layer through which the other applications could access legacy applications which had been service-wrapped. In the second phase, they gradually removed the legacy code into newly-developed code. This approach was a refactoring approach and was adopted because they had to avoid big bang changes.

In a refactoring approach, there exists massive data transformation effort from Legacy System formats to new formats. One challenge in data transformation in this company was that XML transformations were costly. Since the industry product standards were not sufficient, The

company needed a lot of shortcuts (behind standard facades) to achieve the required performance, stability and scalability.

On the whole, the interviewee considers the SOA adoption project in this study as successful though refinements are still in progress. However, the bank considers this project a success since it was a business driven project and it eventually succeeded in terms of reusability, agility, efficiency and productivity as well as in bringing business value to the company.

4.1.3 Success Factors of Migrating Legacy Systems into SOA

1. *Strategy of migration to SOA*: The interviewee insisted that strategy of migration was the most important factor in migration of their legacy systems to SOA. Their strategy of migration has been the refactoring approach.

2. *Business Process of the company*: Another factor which has had influence on integration of the legacy assets is the business process of the company. In the case of this large banking system, the driver for creating a new core banking systems was basically the fact that the business process was not acceptable anymore, neither in terms of time to market nor in terms of supporting the new business model. The bank had an extension strategy to turn from a local bank in one country into a global bank so the business process and the legacy IT systems did not fit together anymore.

3. *Potential of legacy systems* to be migrated into SOA: According to the interviewee, good application structure of more than 25 year-old legacy systems contributed to success in this migration. Level of documentation and code quality were also needed to make a reliable plan for the migration. The tricky part is when the project team want to completely replace the old code because this will require them to have a detailed understanding of the business logic of the legacy applications which is hard to achieve if the original developer is not anymore involved in the project. Sometimes the only documentation is the source code. Here, application modernization analysis tools can help to get an initial picture. But it is often more based on experience than on measurements. Thus the project team used experience instead of measurement to measure the feasibility of converting a set of components in legacy system to SOA. Beside that, size and complexity, scale of required changes in the legacy applications, support software required, reusability factors, service abstraction and service discoverability were also crucial characteristics of legacy system in migration to SOA. The interviewee also mentioned that quality of service including service performance, reliability and security is one challenge in an enterprise-scale migration. This quality is also affected by characteristic of legacy systems as well.

4. *Legacy Architecture*: He also mentioned that security and the architecture of the legacy system can affect the difficulty of the migration effort. When asked about the legacy architecture and its potential for migration, the interviewee mentioned:

   "*Good application structure of 25+ year old legacy systems contributed to success - it pays off to do systems engineering, even if eventually for sunset of the application*"

   If the legacy applications have initially been well-defined and well-structured with various abstraction layers, they are expected to have a pre-defined pattern which will ease the integration.

5. *Closely monitoring:* Another factor he mentioned is closely monitoring the project progress and outcome. In this case, the complexity of the relationship between services(components) and sub-services were not managed very well. There is not enough focus on the service orchestration.

6. *SOA Governance*: In SOA governance, Business and Application Architecture must define the success criteria or business value of the SOA beside the unifying and simplifying aspects of the various projects. The interviewee stated that IT must concentrate on non-functional requirements (NFR) being met as well such as security, auditability, authenticity of messages, performance and throughput. These were used to enable monitoring and to operate the solution. The requirements from potential service users were not considered well enough especially service re-use was a challenge as the NFR of the second user might have been totally different from the first user. This was while the first had set the solution design. In SOA governance, the company considered a Service Level Agreement (SLA) in which the following aspects were considered: availability, throughput, performance and all the interdependencies of all components.

7. *Budgeting and resources*: The interviewee highlighted the role of budgeting, saying:

   "*Legacy systems can open surprises for the budget if the systems are not well maintained and not well understood (anymore). The program must be divided in several phases, where each phase is vital for itself. This allows to stop and continue later, when budget allows.*"

   The budget for the initial phases had been met in this company's experience. This initial budgeting in this case included the service wrapping costs but with the subsequent replacement of the legacy code behind the service layer. The project was developing new code with new services and service wrapping is quite expensive and complicated. As for the resources, the company needed several hundreds of people over 5 to 6 years plus a new IT infrastructure to conduct migration of legacy system to SOA. So they had generally underestimated the required budget.

8. *Dependence on Commercial Products*: This can be a factor which makes the integration even more difficult. Though they did not have such dependencies, the interviewee refers to this factor as a very important one in his interview.

The empirical data for this company can be seen in appendix C 1 – 3.

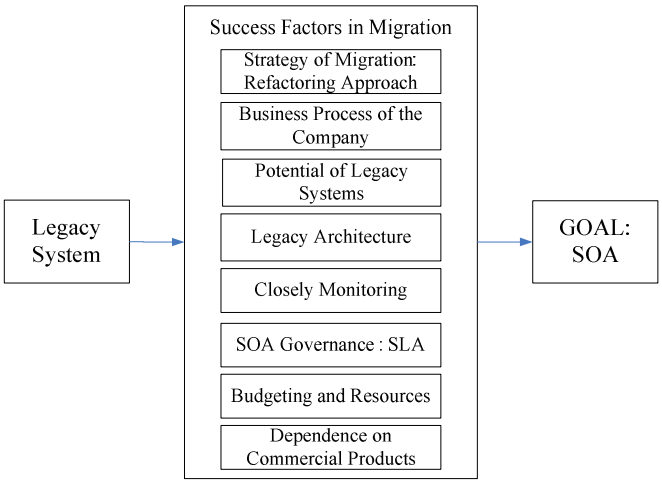

Figure 4.2 Success Factors in Large European Bank

4.2 SAS

Interview Method: Phone Interview and Email
Date of Interview: 27th April 2009

4.2.1 Company Overview

Scandinavian Airlines System (SAS) is the biggest airline in Scandinavia. SAS was founded in 1946. In 2007, this airline flew 31.2 million passengers to 152 destinations with an average of 822 daily departures in 34 countries in Scandinavia, the rest of Europe, North America and Asia. (SAS Group, 2007).

SAS started to adopt SOA in the 1990's and started to develop web services in 2003. Therefore this company could make a good selected experience for our research. In SAS, migration of legacy systems to SOA means new functionality when implementing web services integrated with the existing legacy systems. Thus, they have not been trying to replace the legacy applications with new systems. Instead, they have tried to reuse or use the legacy systems with additional new functions which are integrated with the existing systems to use their functionality.

4.2.2 SOA Adoption

Clarving (2006 cited in Cohen et. al., 2006) has mentioned that competitive global transportation industry made SAS adopt innovative technology in order to more quickly align SAS with the changing market dynamics and provide the highest level of service to the customers.

The main reasons why SAS opted for this service-oriented trend have been based on market purposes as well as feasibility and reusability. Reusable components in SOA have been widely recognized especially in large companies with significant collections of servers and applications. SOA's role in reusing legacy code has extended the life of the legacy systems and has also forced the company to find new methods for managing this code. SAS started its first web services in early 2001 (Braue, 2007). Fagerstedt (2004 cited in Mattsson, 2004) has mentioned that SAS decided to use web services to implement SOA, which is used to implement the company's operational data stores and generic services.

Clarving (2007 cited in Braue, 2007) has explained that using web services had brought more flexibility to the communication between the systems and within the entire environment. There are more than 25 major web services many of which are highly complex and regularly reused throughout the company's application environment. Without using web services, the company would have had large problems in delivering the purpose of the systems. However, SAS is still heavily dependent on their legacy systems and their structure.

Braue (2007) has also mentioned that documentation is important in developing a system both at the business level and also as a technical aid for ongoing system work. It is used to improve controling, logging, tracing and overall governance mechanisms. In his opinion, business processes have not really played any role in the integration with the legacy assets. This could be because the web services are not related to any document-specific business process and they are more developed from a functional requirement perspective in SAS.

In the interviewee's opinion, technical and organizational issues are very difficult areas to control in terms of costs. He mentions how difficult it is to realize which areas to choose and invest in. Web services are costly to produce in a reusable way. A web service should not be too large or too small. They have come to the point that SLAs can be helpful to achieve their goals.

Considering the people who have played key roles in the implementation and success of their service-oriented approach, the interviewee mentioned the system architects and the architecture department as the most important influencing people. According to him, all the projects had a system architect with the main responsibility of designing the system and its architecture.

Monitoring of progress of the projects in SAS is done through architecture reviews made in every phase of each project. The challenge in SAS's strategy towards web service implementation is to develop a web service that can be reused. Their strategy is to keep an eye on all the existing web services, their positions and the services they provide. Regarding the reliability factor, the interviewee mentioned that they were using Microsoft platforms. Of course the reliability of the web services produced will not be as strong as the systems built on mainframes or a Unix mainframe.

The interviewee considers their approach toward service-orientation still in progress. They have made serious efforts in having their organizational legacy applications reused in different projects. However, they would have expected more reusability compared to what they have today.

4.2.3 Success Factors of Migrating Legacy Systems into SOA

1. *Strategy of migration to SOA*: The interviewee highlighted the role of migration strategy in building up a reusable service-oriented architecture.

2. *SOA Governance*: The interviewee mentioned the important role of SOA governance in controlling the growing service-oriented architecture. SAS has defined their own SLAs to avoid losing control and ending up with a spaghetti dish of web services in both their implementation and architecture.

3. *Potential of legacy systems*: There are some characteristics in the legacy systems which can play important roles in the legacy's potential for being integrated with the service-oriented architecture. The interviewee believes that reusability factor of the legacy systems plays the most important role when integrating them with SOA:

   "*I would say number 1 is reusability factor. We are doing development in the legacy system by integrating with the web services. The web services will reuse the legacy system as the component to handle the job. This web services supposed to be reused as the component has its own characteristic. If the legacy system is not possible to reuse it, we can't use the web services. That would be the main issue…*"

   He also mentioned the scale of required changed for integrating the legacy code with web services as the second important feature. According to him, Level of documentation also has a key role and can ease the integration purposes:

   "*…The second is level of documentation. If we have good documentation, it will be easier…* "

He also mentioned the size, complexity and code quality of the legacy applications as well as the supportive software required for them as influencing factors in the trend towards their integration with SOA.

4. *Close Monitoring:* Monitoring of progress of the projects in SAS were done through architecture reviews made in every phase of each project.

The empirical data for this company can be seen in appendix C 4 – 5.

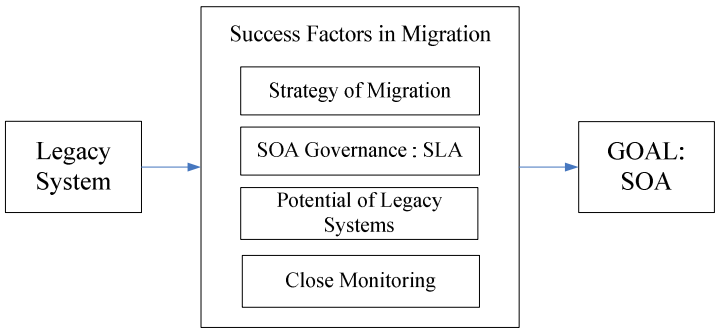

Figure 4.3 Success Factors in SAS

4.3 Large Globally-known Company based in Sweden

Interview Method: On sight Interview and Email
Date of Interview: 28th April 2009

4.3.1 Company Overview

Since the interviewee has asked for the name of the company to be kept undisclosed, we are going to refer to this company as a large, globally-known company based in Sweden. This company has many branches around Europe, North America, Middle East and Asia. The company offers modern style furniture and accessories for its customers.

This large Swedish company started adopting SOA technology sometime in 2004-2005. Therefore, we could gain a lot of valuable knowledge from studying their SOA adoption experience to describe the factors which affect success in migration of legacy systems into SOA in the company.

4.3.2 SOA Adoption

The company started to adopt SOA in 2004-2005. Considering the initial business cases that were the starting point for SOA, they came to some initial estimation about how much it would cost, how long it would take and what benefits they would get in return, none of which have been fulfilled successfully the way they were predicted. Almost none of the business services have been reusable, for instance. And for the benefits, reusability had been a driving force at the beginning but almost none of the business services have been reused. On the other hand, as a result of SOA adoption, the company has a very good end-working architecture with a lot of business services and a basic infrastructure in place with the service catalogs.

Their initial SOA infrastructure, known as ITF (the IT Foundation), has been only for the company's internal service and use. At the moment, they are just in the starting phase of transforming their internet into a much more service-oriented platform. This platform is

supposed to be a real service –oriented one in which they will also consider the partners' perspective outside the company to present their services to.

Replacing legacy systems have been both successful and unsuccessful in this company. For instance, they have this very old store system which was created in late 80's or sometime in the beginning of the 90's. One of the first services created in their service–oriented architecture was a new store system. Although the new system has been was very successful, the old store system is still in use somewhere in the back-end. Thus the company is still relying on its legacy assets and is still struggling with maintenance difficulties which could be very expensive.

According to the interviewee, systems architects have played the most important role in the migration of legacy systems to SOA in this company. Lead developers have also been important in the implementation of the SOA project. Consumers and their perspectives are really important in the project, as well. Beside that, CEO has not been really involved. This is all about IT in this company. Top management have been deciding on how much money to spend to create some business value. But that has nothing to do with the implementation of SOA. In this company, there was a sort of enterprise architecture role at first and then the system architect would not be involved anymore until the next step. It, of course was dependant on the scope of the company's project. The scope here was to totally change everything.

The project has not failed in terms of its promised service. The systems have been able to deliver the functionality needed and they are good from the user perspective in most of the cases. They have a stable and centralized environment with more controllable systems now. They have also succeeded in supporting the company's growth. The SOA adoption in the company was not successful in terms of reusability and budgeting. The project cost a lot more than the budget. Different users needed different outputs. If they had completely reusable components, it could be very complex hard to maintain. So they decided to create more than one component for the same object. Thus, they do not own a 100% SOA environment.

From our interviewee's point of view, the SOA adoption trend has not been over yet in this company. He refers to it as in progress since improvements are still made to the implementation of their service-oriented architecture.

4.3.3 Success Factors of Migrating Legacy Systems into SOA

1. *Business Process of the company*: This company apparantly has a culture in which technology is never allowed to steer the business process. This could contribute and cause some failures. At one point, the interviewee mentioned:

   "…*We have a problem with the business process within this company. We have a culture that says that technology is never allowed to change the business process. That has caused some failures. We in the late 90s were looking into SAP and we realized that it would not be possible for our company to look into SAP without changing any business processes. That was not allowed, therefore we had to create everything ourselves…*"

   And in another part of the interview, he repeats:

   "*Factor d (business process of the company) has really affected us. That is the unwillingness to change the business processes...*"

2. *Potential of the legacy systems* to be migrated into SOA: the company needed maintainability skills in order to find resources in the old code. For the required characteristic in the legacy system, there are two perspectives, one from the business level and the other considering the technical level. Here is a list of the characteristics and features of the legacy applications which in interviewee's opinion can influence the potential of those systems in being migrated into SOA. The sequence in which these features have been listed demonstrate their level of importance in this globally-known large company.
   1. Scale of changes required
   2. Support software required
   3. Size and Complexity
   4. Code Quality
   5. Level of documentation

   Reusability factors, service abstraction, service discoverability are very important in the business level. Those three characteristics are more like what the company has been looking for when migrating to SOA.

3. *Legacy Architecture*: This is also an important factor to consider. For example, all legacy systems had all their logic in the database. Suddenly the company planned to transform those into different thinking and to divide them into services that could be written in a reusable way. One important aspect would be the architecture set-up when logic and data were together and then the decision is to separate them. So in most of the cases, difficulty of the migration process increased due to the architecture of the legacy.

4. *Strategy of Migration*: Their strategy has been to move towards a centralized environment to use the same architecture in almost all of their branches in the world. So everything had to be migrated into this centralized system. The main strategy in the company was redeveloping. So they had to rebuild it by using the structure of the system, part of the functionality or the flow of the code regardless of the language they were developed in.

5. *Dependence on Commercial products*: This company has developed almost everything by themselves. Commercial product had an affect on the migration but it was not very significant. An example would be how the company dealt with their Oracle licenses.

6. *SOA Governance*: This aspect has been used to manage all of the resources in the project in order to ensure service quality, consistency, predictability and performance. They had OLAs and SLAs in which many factors had to be considered and were used as legal contracts and agreements. SLA is the agreement between IT and business. OLA is an underpinning contract or agreement to deliver services under certain circumstances and even maybe through operating specific hardware. The company has a lot of SLA and those can always be enhanced. It is quite easy to write SLA and to create certain points. There are some issues in SLA, which are about functionality and most are about non-functional requirements like volume, expected goal, the number of users, the number of concurrent users and the service response times. .

7. *Testing*: It is important to validate and verify the quality of the services in terms of performance, reliability and security. As soon as the company is working with SOA, they have a development environment and they need a testing environment to be able to integrate the output with the other systems. The interviewee believes that functional

requirements are required to be verified quite early and in integration with others, as he mentions:

"*Tests are very interesting…as soon as you are working with service oriented architecture, you'll have your own development environment for your own development,…then you need a test environment where you integrate with other systems and then you'll need some stage environment….you need to do that quite early. And with integration with other systems. So test is quite tricky. You need to be aware of all the others ..and schedules and maintaining test environments so each component is in the correct version … this has been very very hard to maintain.*"

They need to schedule and maintain their test environments so that each component is in the correct direction when being used which can be very costly and difficult to maintain.

8. *Budgeting and Resources*: SOA adoption has been a costly project in this company costing a lot of time, personnel and hardware. In this case, the real cost and time were around 500% more than the initial estimated budget.

The empirical data for this company can be seen in appendix C 6 – 7.

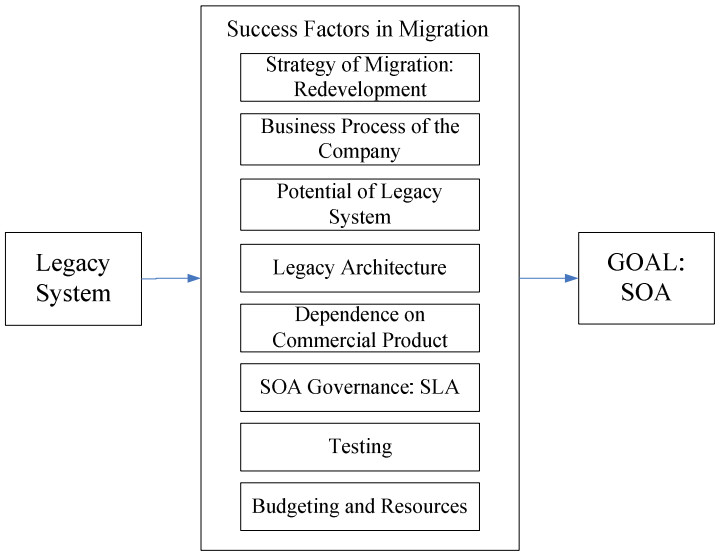

Figure 4.4 Success Factors in Large Swedish Company

4.4 Sandvik

Interview Method: Phone Interview and Email
Date of Interview: 30th April 2009

4.4.1 Company Overview

Sandvik is a Swedish company which has representations in 130 countries in Europe, Asia, Australia, Africa and America. It is a high technology group in engineering with advanced products in material technology. This company develops, manufactures and markets highly processed products in order to improve productivity and profitability of its customers. This company had around 50000 employees plus sales of approximately SEK 93 billion in 2008. (Sandvik, 2009)

We chose Sandvik as one of our selected companies to study because it is one of the early adopters of the web service technologies in Sweden and therefore could provide valuable knowledge to this research. Sandvik started adopting web services in 1988. Sandvik used web service technologies in several systems which have different purposes for each implementation. According to Sandvik's previous research documents (Henkel, 2004), Sandvik is one of the cases which Microsoft used as reference in web service implementation. The company has technically succeeded in migration of its legacy systems to SOA. They decided to deploy SOA for reusing their legacy systems and reducing redundancy. According to second interviewee, Sandvik works in 3 different business areas with different ERP systems. They are trying to organize it around while trying to get to a common integration pattern and enterprise service-oriented thinking. The most important aspect when talking about service-oriented architecture is information architecture. By using SOA, the company expected cheaper development and maintenance beside higher agility.

4.4.2 SOA Adoption

Sandvik works in 3 different business areas. They have different ERP systems in different business areas. They are trying to organize it around while trying to get to a common integration pattern and enterprise service-oriented thinking. The most important aspect when talking about service-oriented architecture is *information architecture* and to get the environment up and running so that it is understood by the consumers and producers. So in their environment, they have almost any kind of object-oriented system and they have almost all the platforms in their infrastructure as well. In their integration package, they have managed to exchange and consume and create information rather than services anywhere in that infrastructure. So concerning the environment, they do not have any problem. The problem is that the information is not understood everywhere. This problem is due to lack of maturity and lack of work. One critical thing is that historically, integration takes a long time. Integration means to standardize, harmonize and to create services for the information objects. In a service-oriented environment, it has been in a way that you have to get the services up and running and you consume everything available anywhere.

Sandvik does have almost all existing environments in SOA. This is mainly due to Mergers & Acquisitions (M&A) and an early adoption of IT with local presence. It started on Mainframe z-series and i-series. Today, it is a combination of own-developed products together with the products available on the market. The company has an integration package that consists of smaller plug-ins available to be used anywhere in the infrastructure. They can act locally but the IT team can always centrally monitor the result. This means being able to be proactive and that it is easier to use for tracing and tracking. It was problematic to get an understanding for establishing a stack of components (plug-ins) which is not relying upon any specific technology. It is able to be executed anywhere and monitored centrally for proactive and monitoring reasons which is the maturity and understanding for what is important and required for success over the life cycle.

There are four roles involved in the SOA project in this company which are project manager, programmers, system architect and infrastructure architect. The project manager uses Project Start Architectures. The programmers should follow the standard and guidelines in creating services where they do not exist and are required. The system architect follows Procter and Gamble (P&G) manufacturing and reviewing initiatives. P&G manufacturing focuses on the product, process technologies and systems. Infrastructure is preferred to have less complexity

because it will be easier when integration is monitored similarly over all applications' landscape.

In terms of SOA adoption success, the first interviewee mentioned that the agility part is critical. It is caused by integration which required a standardized information architecture. With information ownership, stewardship is responsible for establishing business facades and methods upon the information objects. The business facades are re-usable. But since the company has different legacy systems which are not following the standardized information architecture, SOA will be harder to implement. However, standardized information architecture is a pre-requisite for SOA and has nothing to do with IT-development.

When the company had the business facades implemented outside any legacy system, the company was able to deliver services from cell phone within less than a week. There needed to be reference architecture in place, P&G and standards for the projects to be followed. Then the review is a smaller task. The problem historically is that the integration has been forced to structure the information architecture for the objects and services. This is something that has nothing to do with integration. It is as first interviewee mentioned, a pre-requisite for SOA. Long implementation is something that the business often has a problem with, even though it is not a technical problem.

4.4.3 Success Factors of Migrating Legacy Systems into SOA

1. *Technically skilled personnel*: The first interviewee mentioned that skilled personnel played an important role in the success of SOA adoption. This has been due to the fact that the standardization is driven from IT.

2. *Information Architecture*: This is one important factor that first interviewee mentioned in reply to the most effective factor in SOA adoption:

   "*…the success will not be there until the information architecture is handled in a structured way from the business. The SOA approach seldom have its problem on the technical level, the failure is mostly due to low maturity upon the information architecture. Global roll-out of SOA and a possibility to consume the same services globally, requires a global view of the information object.*"

   Low maturity upon the information architecture of the company can lead to failure. This is because global roll-out of SOA and a possibility to consume the same services globally requires a global view of the information object. Therefore, information architecture is required to be handled in a structured way from the business side to provide success to the project. Their SOA approach has seldom had problems on the technical level. So the first interviewee believes that the migration process success is 70% dependant on the business side. This is used to structure the information according to the requirements from processes and capabilities.

3. *Business Process*: Business process of the company has been the most important factor to succeed in migration of the legacy assets in the long run. The first interviewee said that the combination of business processes and information architecture have also been very important in this company. At the beginning, the maturity for working on processes in Sandvik was low on the business side, even though this was a factor for success. The second interviewee also had the same opinion about the business process. He added that

based on the concept of the way business is done in the company, SOA adoption can be very difficult without it.

4. *SOA Governance*: This factor is about governance over information and services. Sandvik also considered SLAs. In the integration of the legacy assets with SOA, they have established SLAs for each service in different solutions. One SLA is expected to cover the information delivered from a legacy system. Another SLA is expected to separately cover the integration phase. Critical is that this is based upon a standardized way of integration and monitoring.

5. *Potential of Legacy systems:* This factor can be seen as the ability to use the legacy systems as components. Sandvik has used an approach which is a combination of using components from legacy systems and also developing new components from scratch when adopting SOA. Since the company had most of its business logic residing in its legacy systems, that logic had to be used as far as possible. Therefore the IT team in the company added the mediation between the legacy and the business facades. The problems are concerning nomenclature and terminology and of course the ability to handle XML in older environments such as mainframes.

   There are some characteristics of legacy systems which should be considered in their migration into SOA including information architecture, reusability factors, scale of changes required, level of documentation and service discoverability. Information architecture is the most important while the reusability factors are more to standardize information delivery. Combination of service discoverability and governance are also connected to information architecture.

6. *Legacy Architecture*: The older architecture was founded in the 70s based upon consumption of information in their systems and not scaled according to the current requirements and of course the older systems are more stable than the newer ones. The requirement was to open up the business logic out of some of the legacy systems. Risk was not initially a big issue but it was a problem concerning agility. SOA will increase the complexity and the number of services required other than governance and co-ordination. The security aspect is also important because the services are consumed by external stakeholders. Performance will often be less effective than internal consumption and system-designed consumption of own information.

7. *Strategy of Migration*: According to first interviewee:

   "The strategy is primarily focusing on standardizing the information architecture, with ownership, so that strategy is to point out what pre-requisites SOA will need. "

   there was a business strategy behind this SOA adoption, based upon the business requirements which were to have a globally harmonized shared information and also building up the Key Performance Indicators (KPIs) on a higher level. The strategy was primarily focusing on standardizing the information architecture, with ownership.

8. *Monitoring*: Sandvik's IT team could always monitor the results centrally for tracing and tracking.

The interesting factor that we have discovered in the case of Sandvik has been the important factor of *Information Architecture*. SOA is all about making information available. It is important to have a common understanding of the information so that everybody knows what a product is and what is contained in the price that is delivered. The delivery price depends on certain algorithms based on the interesting elements within that equation. Beside that, the structure and certain business requirements need to be addressed as well. SOA is a matter of hard work within the information architecture. That is the critical thing that they have found in their SOA experience.

The empirical data for this company can be seen in appendix C 8 – 12.

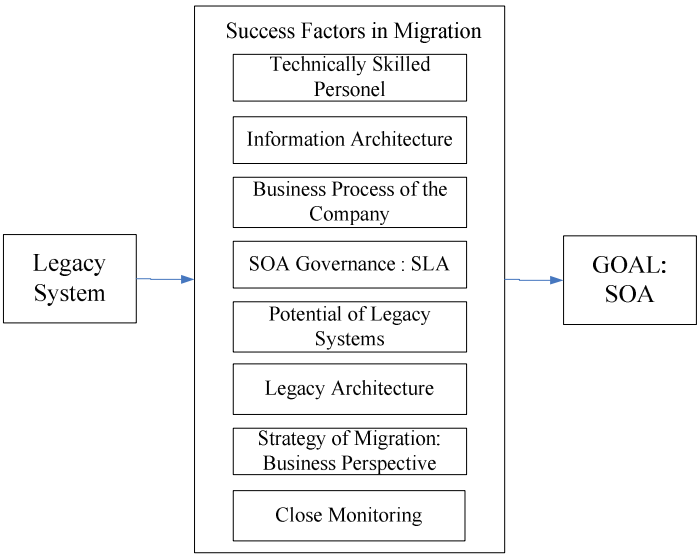

Figure 4.5 Success Factors in Sandvik

4.5 Large UK Bank

Interview Method: Phone Interview and Email
Date of Interview: 8th & 11th May 2009

4.5.1 Company Overview

Based on the interviewee's request the name of this company will be kept undisclosed in this research and it will be referred to as 'a Large UK bank'. This company is a large financial organization in UK.

This large UK bank started adopting SOA in 2002. Therefore studying this company's SOA adoption experience could help us learn more about the factors which affect success in migration of legacy systems into SOA in a company. According to the interviewee, by using SOA, the company expected to attain some benefits including efficiency, transformation, efficiency in terms of speed to deliver business services and ease of creating business processes.

4.5.2 SOA Adoption

In the case of the large UK bank, the interviewee mentioned that the first thing they considered was legacy system integration into new components. In this company's enterprise

system, the company started to analyze the structure of the services while the interface was still assigned. The program staff thought about interface in the transition phase of it so that the interface specification is hiding in interface implementation. So at first, the project was about the legacy systems and in the second place, it was about the new back end.

In SOA adoption, the company needed people who had business analysis skills as well as a system integrator. This was because some knowledge about how to analyze the company's top-down from the business architecture to technique architecture interfaces was required. They mainly used IBM for the control system integrator. So the organization is strong on top-down business analysis. The company has strong technical people in migration of legacy systems where the company finds service modeling based on the business analysis.

Furthermore the interviewee mentioned about Brownfield which is used in developing new systems in SOA as the immediate presence of legacy system. Pugh and Jenks (n.d.) explain Brownfield as *"an urban site for potential building development having had previous development on it"*. In other words, Brownfield is all about utilizing an existing environment and following the existing patterns in order to minimize risk. This is while Greenfield defined by Pugh and Jenks (n.d.) as *"denotating previous undeveloped sites for commercial development or exploitation"* which means working in a new environment and adopting new approaches with a fairly open scope and no constraint imposed by previous work.

Brownfield improves the legacy software engineering practice and is an extension to Greenfield. Instead of using the Greenfield concept, the interviewee has worked within Brownfield. It is used to try to understand the detail field on the system relying on the sample, especially if the system is undocumented. It is also used to analyze the application and the data in the system in order to know what and how to transform the legacy system. Many people still think of using the legacy systems and try to understand how much transformation would happen in their legacy systems. However, people prefer it to be much more flexible. The interviewee added that they could not really know how to work with the services in the project without starting until the constraint of the legacy system can be analyzed using automated technique with Brownfield or using manual analysis.

In SOA adoption, the interviewee mentioned that quality of service had been quite important. The IT team in the company needed to understand the system if they wanted to reuse the legacy system to provide the services implementation. The reliability and performance factors have been important, too. Therefore they needed to back up the system. To support the quality of service, the company has an SLA for the application level in developing the enterprise system. When they are looking inside the organization, they might not have a central SLA in the legacy systems. But when they start to think about creating new services and then migration, they are always trying to go to the processes of SOA inside the organization and this is where SLAs are created. This is the first step towards the implementation of services government.

4.5.3 Success Factors of Migrating Legacy Systems into SOA

1. *Business Process of the Company*: The most important factor in this company has been its *business process.* In this company, SOA adoption required changes in its business process. Fundamentally, the way SOA works is by separating service specification from the implementation in order to help the business.

2. *Legacy Architecture*: when asked about the architecture of the legacy systems, the interviewee answered:

   "*It(Legacy architecture) usually increases difficulty. First, we have to find the interfaces and then the legacy system usually uses on it. They have the architecture and built documented and also have different packages and different technologies which play on it. So interface analysis is usually to find how the (legacy) architecture is.* "

   The business process is dependent on the legacy architecture. The IT team had to break the business process into two groups of the ones which can be reused and the ones which require new services to be defined for them. Then they established the services implementation for the existing systems.

3. *Budgeting and Resources*: This is all about how to manage the costs. For successful transformation, the company needs some software analysis including the cost estimation and number of functions required. According to the interviewee:

   "*I think the successful transformations are the ones with cost of services analysis before they begin. We do things like function point counting and all the techniques that go around that just to understand the size and complexity and what needs to be migrated. This kind of study usually tells you how big your transformation is.*"

   The analysis is used to understand the size and complexity of the legacy systems in order to know what to be migrated and how big the transformation will be. They have to understand the system and its documentation very well. Regarding the budget, the project's total cost consisted of hardware, software and services cost. The cost can also come from external consulting services as well as internal people. It usually requires millions of dollars and its duration is expected to take 3 to 5 years which requires the company to adapt with rapid market changes.

4. *Potential of the Legacy Systems*: In the migration process, it is necessary to know how much the legacy systems constrain the process. The characteristics of the legacy systems are therefore necessary to be considered. The interviewee mentioned size and complexity as the most important features of the legacy systems. Service discoverability and service abstraction are also considered important by him. He added that Brownfield is used to find out how to do the migration and to understand the size and complexity of the system. Service discoverability is used to know what potential services are hidden from the legacy system and what kinds of services are needed to be exposed. Then the service abstraction is used to find out how to convert it into new services. The interviewee also mentioned other characteristics such as level of documentation, reusability factors, scale of changes required, support software required and code quality.

5. *Strategy of Migration*: The bank's strategy was to extend the services. The company especially the IT team had to be careful with their thinking and interpretations in creating new functions. This factor is the first thing they need for understanding the existing systems in order to know how to handle the migration process. Many ways exist for the translations in the project stages. They look at the new packages or new services which are defined by the business process of the company. The point that they should consider is how the organization accepts the transition of the system. They would create the centre of the system and then the other processes would come around that.

6. *SOA Governance*: Their legacy systems did not have SLAs but they started creating SLAs when starting to migrate the legacy applications into the service-oriented architecture.

7. *Closely Monitoring*: The Company also hired a *monitoring mode* all the time in order to help the strategy of migration of the company to move forward with the system. They used some transformation measurement in order to help the company keep on the top measurement. Early signs of failure were also spotted at some points.

The empirical data for this company can be seen in appendix C 13 – 14.

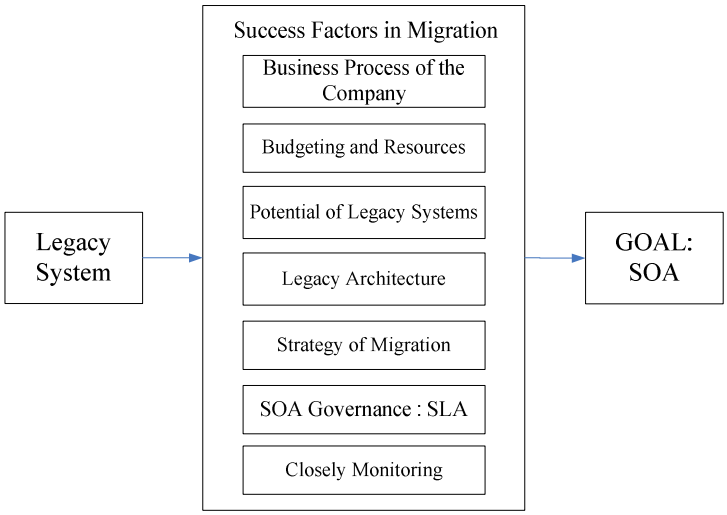

Figure 4.6 Success Factors in the Large UK Bank

5 Analysis and Discussion

This section is used to analyze our findings in the five different companies. These findings are then discussed further and motivated.

In our analysis of our empirical findings, we decided to use cross case synthesis based on Yin (2003) so that we could aggregate our findings across the series of individual studies and draw cross case conclusions about them through using word tables. Therefore we created four word tables in our analysis, three of which display the factors that were applied in individual studies to migrate their legacy systems into service-oriented architecture. Factors have been categorized in technical, business-oriented and technical-business tables. The last word table displays the sub factors affecting the potential of the legacy systems in each study to be migrated into SOA. This chapter will cover the mentioned word tables as well as their drawn conclusions.

As already mentioned in chapter 2, we had categorized the potential factors into two categories for the interviews based on two technical and business perspectives. However after conducting the interviews, we realized that there exist some factors which can be seen in both technical and business perspective. Therefore we have added a new category called technical-business perspective which can cover the factors which are related to both Information Systems' technical aspects as well as the business-oriented aspects of the company.

5.1 Cross Case Synthesis – Business Perspective

Business perspective in this research refers to the business-oriented aspects of migrating legacy assets to SOA in a company. In the word table of the business perspective (Table 5.1), the two factors of *Business Process* and *Budgeting Plan and Resources* of the company have been considered. Business process represents the routine of the company for handling the tasks of the business while Budgeting and resources are factors used to support the company throughout the SOA implementation and of course are allocated and assigned to each project by the business leaders of the company.

As seen in the word Table 5.1, the *business process of the company* has been mentioned as an influencing factor in 4 out of 5 of the companies under study. *Budgeting and resources*, as the second factor from the business perspective, has been mentioned by 3 out of 5 companies as a success factor.

Table 5.1 Success Factors in the Business Perspective

Company	Business Perspective Factors	
	Business Process of the Company	**Budgeting and Resources**
Large European Bank	It has been one of the factors. The driver for creating a new core banking system was basically the fact that the business process was not acceptable anymore both in terms of time to market and also in terms of supporting the new business model.	It is one of the factors. Legacy systems can open surprises for the budget if the systems are not well maintained and not well understood anymore. Everything had been on target regarding the budget plan in this project, though.

Company	Business Perspective Factors	
	Business Process of the Company	**Budgeting and Resources**
SAS	It has ***not*** been a factor in SAS.	It is ***not*** considered as an influencing success factor. Each project had its own separate budgeting and the estimation of costs was handled by the vendors of each project.
Large globally-known Swedish Company	It is the second important factor considered by the company. The company has a culture that technology is never allowed to steer the business process.	The project cost a lot of hardware and human resources which made it a significant factor.
Sandvik	Combination of business process and information architecture made the most important factors in migration to SOA.	It is ***not*** considered as a factor
Large UK Bank	It is the most important factor in the large UK Bank. SOA adoption needed changes in the company's business process.	It is the second factor. It is talking about how to manage the cost. For a successful transformation, the company needed software analysis, including the cost estimation, number of functions needed, etc. The project's total cost consisted of hardware, software and services costs. Other costs could also be from external consulting services and internal people. It usually needed millions of dollars and it would take 3 to 5 years.

5.2 Cross Case Synthesis – Technical Perspective

As mentioned earlier in chapter 2, Technical perspective covers the factors which are directly related to Information Systems' technology and their boundaries in migration of the legacy systems. We discovered seven factors affecting the migration of legacy systems in our five companies which belonged in this perspective. Those factors include the potential of legacy systems for migration into SOA, legacy system architecture, information architecture, dependence of the legacy assets on commercial products, close monitoring, testing and technical skills. The reason for this categorization has been the direct relevance discovered based on the findings of the interviews between the mentioned factors and the technical aspects of migration rather than the business-oriented ones.

In word Table 5.2, we can see that the *potential of the legacy systems to be migrated into SOA* has been mentioned as an affecting factor in all of the 5 cases. *Architecture of the legacy systems* and *close monitoring* have each also been considered as factors in 4 of the 5 companies. This is while the factor of *dependence of the legacy applications on commercial products* has been mentioned in 2 of the selected companies and the other factors such as *information architecture*, *technical skills* and *testing* have each only been mentioned as affecting in only 1 case.

Table 5.2 Success Factors in Technology Perspective

Company	Technical Perspective Factors						
	Potential of the Legacy Systems	**Legacy Architecture**	**Information Architecture**	**Dependence of the legacy on Commercial Products**	**Close Monitoring**	**Testing**	**Technical Skills**
Large European Bank	It is their second factor. Good application structure of more than 25 year-old legacy systems contributed to success in migration of legacy system to SOA.	It is one of the factors, it is part of the potential of legacy system. The architecture of the legacy system could affect the difficulty of the migration effort.	***Not*** mentioned this factor.	It is also considered as the factor. "You are better off, if you determine this up-front. You are not in a comfortable position, if you need modifications to a COTS (commercial, off-the-shelf) product and this is the last thing required before you decommission it. The vendor might be rigid." (Furth, 2009)	They considered it as a factor especially in monitoring the project progress and outcome.	***Not*** mentioned this factor	**Not** mentioned this factor
SAS	It is the most important factoring SAS due to the reusability. There are some characteristics in the legacy systems which can play important roles in their potential and the way they can be integrated with the service-oriented architecture.	It is ***not*** a factor.	***Not*** mentioned this factor	It is ***not*** considered as the factor	Monitoring of the progress of the projects in SAS was done through architecture reviews made in every phase of each project.	***Not*** mentioned this factor	***Not*** mentioned this factor

Company	Technical Perspective Factors						
	Potential of the Legacy Systems	**Legacy Architecture**	**Information Architecture**	**Dependence of the legacy on Commercial Products**	**Close Monitoring**	**Testing**	**Technical Skills**
Large globally-known Swedish company	This factor is one of the factors. Migration is always seen in the context of how the legacy system can be used within SOA.	This is one of the factors because it has been important for them to learn whether the logic and data were together in the legacy architecture or not.	***Not*** mentioned this factor	It is considered a factor, but not a significant one. An example would be how the company dealt with oracle licenses.	They did ***not*** consider it as the factor	Only this company added this factor as a factor. Their company needed a testing environment when they wanted to integrate with the other system.	***Not*** mentioned this factor
Sandvik	One of the factors mentioned by Sandvik. They used a combination of using components in legacy systems and new components when adopting SOA.	This is one of the factors. The older architecture in Sandvik was founded based upon consumption of information in their systems and not scaled according to the current requirements.	This factor is important. Success will not be there until the information architecture is handled in a structured way from the business.	It was ***not*** mentioned as a factor.	Their IT team could always monitor the result centrally for tracing and tracking.	***Not*** mentioned this factor	Only Sandvik added this factor as a factor because the standardization of their systems was driven from IT.
Large UK Bank	This factor is one of the factors because in the migration process they needed to know how much the legacy systems constrained the process.	This is one of the factors because the business process of the company is dependent on the legacy architecture.	***Not*** mentioned this factor	It is ***not*** considered as the factor	They considered it as a factor. The bank involved a monitoring mode all the time in order to help the strategy of migration in the company to move forward with the new system.	***Not*** mentioned this factor	***Not*** mentioned this factor

5.3 Cross Case Synthesis – Technical-Business Perspective

Throughout this research study, we discovered 2 other affecting factors, *strategy of migration* and *SOA governance*, both of which could be categorized as both technical and business-oriented. Strategy of migration plays an important role in selecting a proper technical strategy for adopting SOA beside the role it plays in the business decisions related to this migration. SOA governance can also be relevant to both the technical and business aspects of migration through defining both business-oriented and technical SLAs. Therefore, we defined a hybrid perspective called the technical-business perspective which can cover the factors which are related to Information Systems' technical aspects beside the business-oriented aspects of the company. We designed a separate word table (Table 5.3) to display the role of these factors in our five separate studies.

Table 5.3 Success Factors in both Business and Technology Perspective

Company	Both Business and Technology Perspective Factors	
	Strategy of Migration	**SOA Governance**
Large European Bank	This is the most important factor. They used the refactoring approach	This has been one of the factors. Business and application architecture define the success criteria or business value of SOA as well as the unifying and simplifying aspects of the various projects.
SAS	This is also one of the factors in SAS. SAS representative highlighted the role of migration strategy in building up a reusable service-oriented architecture.	It has been the second important factor after the potential of legacy system which has been necessary in controlling the growing service-oriented architecture in SAS. They had defined their own SLAs to avoid losing control and ending up with a spaghetti dish of web services in both their implementation and architecture.
Large Swedish Company	Strategy is the most important factor. They had the redevelopment strategy.	This is one of the factors used to define SLAs to manage all the resources in the project in order to ensure service quality, consistency, predictability and performance.
Sandvik	This factor is important especially in business strategy. Their strategy was primarily focusing on standardizing the information architecture so it helped to recognize the SOA pre-requisites.	It is one of the factors in Sandvik, which is about governance over information and services. They also have SLAs in the company.
Large UK Bank	This is also one of the factors in the company. Strategy was used to extend the services in this company. The IT team had to especially be careful with their thinking and interpretation in creating new functions.	It was a factor. They have SLAs for migrating the legacy systems into the service-oriented architecture.

As seen in Table 5.3, *strategy of migration* and *SOA governance* were both influencing factors in all of the 5 companies.

5.4 Cross Case Synthesis – Sub Factors in the Potential of Legacy Systems

We, in this study, discovered eight characteristics of the legacy systems which can affect their migration into SOA. These factors include *the size and complexity of the legacy applications*, their *level of documentation*, *scale of changes required*, *support software required*, *reusability factors*, *service abstraction*, *service discoverability* and *code quality*. Table 5.4 shows the priority ranking of the characteristics for each company from 1 (most important) to 8 (least important).

As seen in Table 5.4, each company has had its own different approach and thinking towards the sub factors affecting the potential of legacy systems. From the table we can see that there are *three* characteristics, which have always been mentioned in the top five characteristics in all of the separate studies. These sub factors include *size and complexity*, *reusability factor* and *level of documentation*. Other sub factors such as *scale of changes required*, *support software required*, *service abstraction*, *service discoverability* and *code quality* have also been important.

Table 5.4 Characteristics of Legacy Systems

Company	Ranking of the sub factors in the Potential of Legacy Systems							
	Size & Complexity	**Level of Documentation**	**Scale of Changes Required**	**Support Software Required**	**Reusability Factors**	**Service Abstraction**	**Service Discover-ability**	**Code Quality**
Large European Bank	All in the same level.	All in the same level.	All in the same level.	All in the same level.	All in the same level.	All in the same level.	All in the same level.	All in the same level.
SAS	4	3	2	6	1	7	7	5
Large Swedish Company	3	5	1	2	Important in business case	Important in business case	Important in business	4
Sandvik	2	4	3	Not mentioned	2	Not mentioned	5	Not mentioned
Large UK Bank	1	4	6	7	5	3	2	8

5.5 Discussion

As mentioned earlier in chapter 3, we have used the theoretical propositions strategy. We carried out a literature review to learn about the possible factors which can influence conducting the migration of legacy systems into SOA. In our propositions, the affecting factors include *potential of legacy systems for migration, strategy of migration, SOA governance, business process* and *budgeting*. We then used interviews and their empirical data to investigate if those played a role in the companies. To analyze our empirical findings, we did a cross-case analysis and came to some results.

According to our cross-case analysis which has been based on our empirical data findings as well as our literature review, we have come to the following factors in different perspectives:

1. Business Perspective:
   a. Business Process of the Company
   b. Budgeting and Resources
2. Technical Perspective:
   a. Potential of Legacy Systems
   b. Legacy Architecture

   c. Close Monitoring
   d. Other factors including Information Architecture, Dependence on Commercial Products, Testing and Technical Skills
3. Technical-Business Perspective:
   a. Strategy of Migration
   b. SOA Governance

Business Process of a company defines the way its routine tasks are run and it is usually handled by the legacy applications in a company. Therefore it is important to consider the company's business process when it comes to migrating the legacy assets into service-oriented architecture.

Budgeting and Resources also play an important role in our findings since migration is a costly process in terms of monetary, human and time resources and therefore it is important for the companies to consider their budget and resources boundaries when they decide on the migration of their legacy into SOA.

Potential of the legacy applications is required to be taken into consideration before starting the migration. This is due to the fact that not all the legacy applications have the potential to be integrated and reused as components or services in SOA. Therefore, there are some sub factors to consider when it comes to the potential of legacy systems for integration in SOA:

1. Size and Complexity
2. Level of Documentation
3. Scale of Changes required
4. Support Software required
5. Reusability factors
6. Service Abstraction
7. Service Discoverability
8. Code Quality

The architecture of the legacy systems is also important when it comes to their integration with SOA because the business process of the company is dependant on the architecture of the legacy applications. Beside that, both logic and data of the legacy applications reside in the legacy architecture.

Close Monitoring is another factor to consider when migrating the legacy assets. Monitoring the migration process can help notice early signs of failure and then take measures for fixing the existing errors.

Strategy of Migration is one factor which is necessary to consider when integrating the legacy with SOA. It is based on the migration strategy either being technical or business-oriented that companies decide whether to reuse the legacy assets as components or web services or to apply redevelopment.

SOA Governance has also been a factor in the migration process. It can define boundaries and regulations for legacy migration through agreements known as SLAs which can be technical or business-oriented.

Comparing our proposition with our findings, we can see that they are not much different. There are some additional factors which were not mentioned in the propositions, though.

These other factors which include *Information Architecture, Dependence on Commercial Products, Legacy Architecture, Close Monitoring, Testing* and *Technical Skills* have also been important in the migration of the legacy systems in the five separate studies. *Information architecture* defines the flow of information in a company. *Dependence of the legacy assets on commercial products* can define some constraints when it comes to the integration of the legacy applications with SOA. The *legacy architecture* of the company is based on the information architecture and it also defines the business process of the company. As already mentioned, *Close monitoring* for the migration process can be an affecting factor in the migration since it can help the migration board recognize sings of early failure and take the required measures to prevent it. *Testing* has been mentioned as a factor in one of the cases since the legacy components require a test environment before getting integrated in the service-oriented architecture. *Technical skills* of the project team members can also be a factor in the speed and quality of migration.

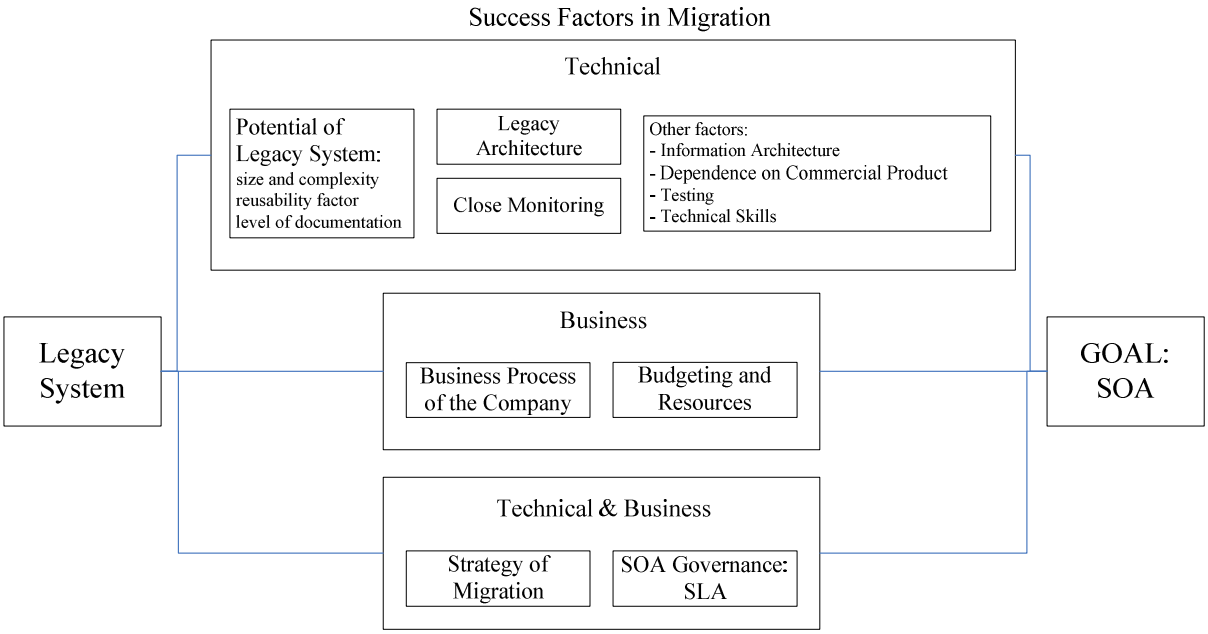

Figure 5.1 Success Factors Model

The summary of the findings in the five companies under study in this research can be seen in table 5.5. The recognized factors in each company have been marked by a (√) sign. The column *Occurrence* demonstrates the number of times each factor has been mentioned as a recognized factor among the different companies.

Table 5.5 Overview of the Factors

Factors	Large European Bank	SAS	Large Swedish Company	Sandvik	Large UK Bank	Occurence
Business						
Business Process of the Company	√	-	√	√	√	4/5
Budgeting and Resources	√	-	√	-	√	3/5
Technical						
Potential of Legacy System	√	√	√	√	√	5/5
Legacy Architecture	√	-	√	√	√	4/5

Factors	Large European Bank	SAS	Large Swedish Company	Sandvik	Large UK Bank	Occurence
Close Monitoring	√	√	-	√	√	4/5
Information Architecture	-	-	-	√	-	1/5
Dependence on Commercial Product	√	-	√	-	-	2/5
Testing	-	-	√	-	-	1/5
Technical Skills	-	-	-	√	-	1/5
Technical & Business						
Strategy of Migration	√	√	√	√	√	5/5
SOA Governance	√	√	√	√	√	5/5

6 Conclusion

This section covers our findings of this study in general. Factors which affect migration of legacy systems to SOA in a company are discussed in general based on the five companies' experiences and their cross case analysis results. Areas for future research are also discussed in this section.

6.1 Success Factors in General

As our conclusion in this research study, we generalized the success factors found in our studies based on the common factors mentioned by all the interviewees in all five of our companies as well as our literature review.

It must be mentioned that this generalization is still in the context of our research study. As for the specifications of this context, the selected companies had experienced a SOA adoption in which the legacy systems had been migrated into SOA. We selected five different companies in order to widen the case basis and therefore come to more general conclusions. Since our research study is a descriptive study, we prepared the theory for generalizations in the sense of collecting specific observations about success factors as basis for discovering similarities. We used cross case synthesis technique (see Chapter 5) to find these similarities (see Table 5.5).

6.1.1 Research Contribution

In conclusion, we have come to a list of affecting factors in migration of legacy systems into SOA based on our empirical findings as well as the literature review (Figure 6.1). The complete list of these factors includes:

- Potential of legacy systems,
- Strategy of migration,
- SOA governance,
- The business process of the company,
- Budgeting and resources,
- Legacy architecture,
- Close monitoring,
- Dependence on commercial products,
- Information architecture,
- Testing
- Technical skills of the personnel.

Out of all these factors, we discovered that the potential of legacy systems for being migrated, the strategy of migration and SOA governance have been mentioned by all the five companies in this research. Business process of the company has been considered by four of the companies while the SOA budgeting plan is considered by three of the companies.

Beside the five factors found in the literature (*strategy of migration, potential of legacy system, SOA governance, business process of the company and SOA budgeting*), we also discovered two other factors, *the legacy architecture* and *close monitoring*, which have each

been mentioned as an affecting factor by four of the companies in this study and therefore have been added to the list of factors above.

Other factors in migration have only been considered by one or two of the companies. These factors include:

- Dependence of the legacy systems on commercial products,
- Information architecture,
- Testing
- Technical skills.

Out of all these factors, we discovered that only three of them have been applied and mentioned as affecting by *all* of the five companies (see table 6.1) and therefore can be generalized as the affecting success factors when migrating legacy systems into SOA considering the context of transferability in this research. These factors include:

1. **Potential of legacy systems to be migrated into SOA**
2. **Strategy of migration**
3. **SOA Governance**

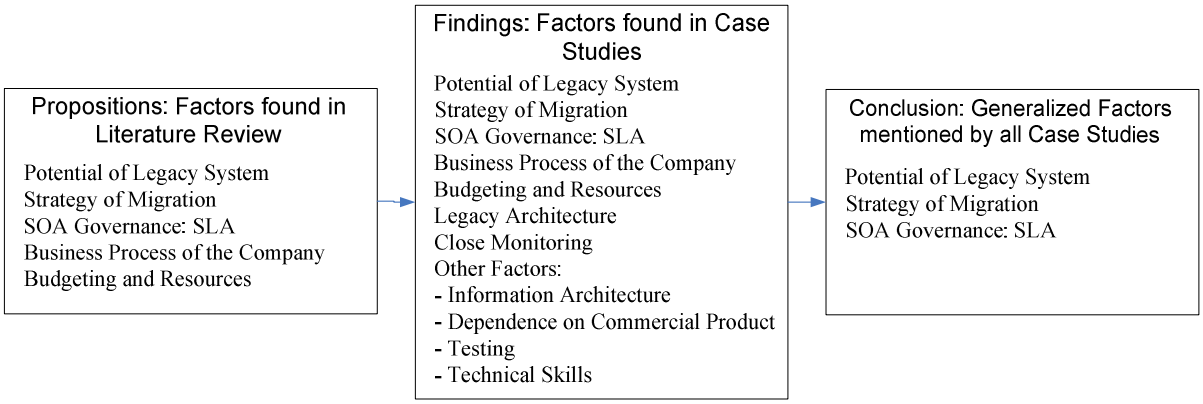

Figure 6.1 Conclusion of Success Factors

6.2 Future Research

Since this research study is not a quantitative research, it would be interesting to test the success factors identified in this research by performing quantitative research. It can be feasible to include larger number of people or organizations in a quantitative research in order to generalize the success factors in migration of the legacy systems to SOA.

Another interesting area for further research would be comparing the two perspectives of IT and business people about the affecting success factors in migration of legacy systems to SOA. Such research can be either focused on one specific company or in general among some different companies.

Furthermore, since our research study has been a descriptive study describing the factors in the migration process of the legacy assets into SOA, there is still room for further exploration of our findings on how far they affect the migration process. Such research can be carried out in both qualitative and quantitative methods with a focus on an exploratory study.

Appendices

Appendix A - Protocol of the Research

An overview of the multiple- study project

In this study, we will study and focus on the key factors which affect the success of a SOA migration project within an enterprise. These factors can be either technology- or business- oriented. Since the affecting factors vary from one company to another, based on the company's technical architecture as well as its business initiatives, this research is designed to be a case study on the affecting factors in one specific enterprise.

There have already been some earlier studies carried out on this topic, most of which have either not been deeply and successfully considered in many corporations when performing a SOA migration project or not been applicable in all types of enterprises with different IT layouts and structures. Proof of this claim is the many number of unsuccessful SOA migration projects all over the world. This could be due to the enterprise level differences which can make earlier studies inadequate for each and every company. Therefore one can realise the need for further study into the business and technical aspects of migration and adopting SOA within a specific enterprise before it actually starts, all through the migration journey and through its end.

We are therefore going to focus on the investigation of business factors as well as technological factors involved in a particular company which has either already opted for migrating to SOA or is planning to start its migration. If we get the chance to study this issue in several companies, then we will focus on generalising the study results to reach a standard for the step by step success of a SOA migration process.

The results from the investigation made in this study can be further used and referred to in the future projects of migration to SOA and SOA adoption in similar corporations with similar technical layout and business perspectives. The investigation results can also be used as academic reference and other researchers can also carry on with our path to complete the research and its results.

Field procedures

The research topic we have well defines that the study under way will be a case study of success factors in migration of legacy system to SOA in a company. We chose case study for our research study in order to know directly from the companies we studied. Based on Yin (2003), when conducting the research we should consider three conditions, which are the type of question research, the control an investigator has over actual behaviour events and the focus on contemporary as opposed to historical phenomena. From those three conditions, the most important condition to differentiate among various research strategies is to identify the type of research question being asked. In this research study, we use "what" questions which mean we want to describe something, in this case we want to describe the factors which affect success in migration of legacy system to SOA.

The research methods to apply for this case study vary from literature review to interviews. We will address each method of our choice in detail. It should be mentioned that the major research method applied on this study will be interviews.

Literature review is one method to initially apply before getting started with further studying the issue. Surveying the literature available to the core topic of SOA can help us update our knowledge on where other researchers have been so far and if we can apply their findings in anyway to our specific case study. It can also provide us with good background knowledge on the topic and history of SOA. This research is aimed to be later published to add to the material already available on influencing factors in SOA implementation and adoption success.

Beside the literature review method, we will study the project documents as it has been in progress in the company under study. Project documentation can help in specific factors related to the success or failure of the whole project in the case study.

After doing the literature review, we will continue the research study with carrying out interview about the topic. We use the findings in literature review as the guidelines to create the interview guidelines. The survey is used to structure and standardize the question in order to reduce bias. (StatPac Inc., 2008).

The company's business and technical members, who have been involved in the project, specifically in the project leading team, are required to be interviewed in detail. Such detailed interviews can provide a close perspective on the real-life reasons to SOA implementation and adoption success or failure in the company under study. Since we will be studying the success factors of SOA migration in a company, interviews will be more practical than survey questionnaires. One reason could be that there are far less people involved to be studied in a case study of one company compared to a more general study of a couple of firms to be in focus with much more people involved in the same projects in different companies and a bigger amount of data to cover.

Case study questions

Introduction:

1. Company name:
2. Working position:
3. Duration of employment at the company:
4. Do you want your answers to be treated confidentially?
    a. Yes
    b. No
5. Has your company succeeded conducting migration from legacy system to SOA?
    a. Succeed
    b. Failed
    c. Still in progress
6. When did the company adopt SOA?
7. Can you provide a short description of the company SOA environment?
8. Why did the company decide to deploy SOA?
   a. What benefits did the company expect to attain?
9. What role has each of the following people played in the implementation and success of the SOA project?
    a. CEO
    b. Project manager
    c. Programmer
    d. System Architect
    e. Other party, which are ….

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
    a. Potential of legacy system
    b. Strategy of migration
    c. Governance of SOA
    d. Business process of the company
    e. Budget of conducting migration
4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required

e. Reusability factors
f. Service Abstraction
g. Service discoverability
h. Code Quality

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
16. How far have you considered the requirements from potential service users?

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?

Thank you for your time and participation in our research study!
If there is any further questions would arise, is it okay if we get back to you with the questions?
Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

A guide for the case study report.

A report should be easy to follow by the audiences or the readers. Therefore the outline of the report should be systematic. A research report should contain some components, which are title and cover page, abstract, acknowledgement, table of contents including list of tables, figures, introduction, literature review, methodology, research findings, analysis and discussion, conclusion and recommendation, references and annexes (data collection tools or tables). Abstract is a summary for the whole content of research report. It should contain brief description of the problem, the main objectives, place of the research study, type of study and methods used, major findings, conclusions and major recommendation. Thus abstract consist of the summary how we conduct the research about factors affect success in migration from legacy system to SOA. (The International Development Research Centre, n.d.)

Furthermore introduction part discusses more detail about the background of the research study, the research area, research scope and the purpose of the research study. This introduction part for this research study is explained in chapter 1. Furthermore literature review consists of the literature used to support the research study. It can be from articles, journals, books, e-books, websites, or other resources. For this research study we will focus on the literature about migration from legacy system to SOA, business process theory and enterprise system. They are explained in chapter 2. Then in methodology section, we will discuss about how we collect and analyze required data in this research study. This methodology is explained in chapter 3. (The International Development Research Centre, n.d.)

Furthermore we continue with research findings. The systematic of the research findings related to the research purpose is crucial part of the report. The empirical findings are discussed in chapter 4 – 7, which each chapter is used for one case study. After research findings, we will show the result of our analysis, including the tables, figures and the interpretation of the findings. In discussion section, the finding can be discussed more detail related to objective, all possible factors in migration to SOA and to the research area. They are explained in chapter 8. Furthermore the conclusion and recommendations section should follow from the discussion of the findings. Conclusion should be short as result of the discussion. Recommendations should be not only from the findings of the research study but also information from other resources in the same research area. Those conclusion and recommendation are mentioned in chapter 9. Then for the references, we will use Harvard system. The last section is annexes or appendices. It is used to put additional information needed to follow the research study procedures or data analysis. (The International Development Research Centre, n.d.)

Beside the outline of the report, we will also consider some other aspects in writing report. Language is one of the important things in writing report. The language used should be clear and using correct tenses. For this research study, we will use English as our language because most information and literature review are in English. The coherence of the report should be considered. The coherence is from paragraph unity and sentence cohesion. It can use linking verb to make it better. Another aspect is validity of the report. We will use proper literature review and proper quote to support our findings in order to consider the validity of the report.

Appendix B – Interviewee Information

Company	Interviewee Expertise
Large European Bank	The interviewee has worked in IBM as an IT architect for 9 years (since 2000) with 6 years of it in the bank's SOA project. He has been involved in very large core-banking renovations with SOA approach. He has spent 3 years for designing and developing SOA and 3 years for improving the performance and stability of the system in the bank project. Therefore his valuable knowledge would make him a perfect interviewee for this case in this study. He also works as a Client Technical Advisor and IT Architect for customers of IBM (Wealth Management)
SAS	The interviewee is a development and maintenance coordinator. His main responsibilities are in the area of strategic decision making regarding governance of IT development and maintenance and therefore he refers to himself as a strategic IT manager. He has worked in SAS for the past seven years. Since he has been personally involved in creating new SOA functionalities in SAS systems and then integrating them into SAS' existing legacy systems in order to implement the SOA concept, his valuable knowledge can be very important in our research study in investigating the factors which affect migration of legacy system into SOA.
Large Swedish Company	The interviewee has been responsible for the company's internet technical platform and he has worked in this company for seven years as an infrastructure manager. He is responsible for the company's internet infrastructure as well as the company's architectural roadmap and thinking. Currently he is still seriously involved in the current platform infrastructure upgrade. Therefore his valuable knowledge will be very helpful for the case study of this company. As the infrastructure manager in the company's internet technical platform, he mentioned IT Information Library (ITIL) which is a collection of best services and infrastructure management and provides service management and modules how to take care all services in the company. There are three roles in the company which are related to the services. The first role, which is also his role, is being responsible for running the services. The second role is supporting the services from the user perspective. The third role is of an application manager which is all about maintaining the application.
Sandvik	First Interviewee: As mentioned earlier, Sandvik works in 3 different business areas. The first interviewee is currently working for one of them and he knows exactly how their infrastructure is like. His working position is manager enterprise architecture or chief architect in Sandvik. He has worked in Sandvik for 29 years. He is very familiar with our research study because he has been responsible for the transition of Sandvik's legacy system into SOA from both business and technical points of view. Second Interviewee: The 2nd interviewee's working position is CIO for Sandvik Materials technology. He is responsible for Sandvik IT strategies, one of which is SOA thinking and an approach to SOA. He has worked in Sandvik since 2003. His valuable knowledge especially in business perspective contributed a lot to our case study.
Large UK Bank	The interviewee works as a Senior IT Architect in IBM Global Business Services for Complex Systems' Integration in UK. He has worked in IBM since 1993 and has been involved in SOA projects and system integrations since 2001. His roles in IBM include solution leader to business transformation programs, making decisions for delivering the IT systems, picking technologies, designing technical solutions and managing delivery teams. These solutions typically involve complex systems' integration of new and existing system components combined with business process re-engineering and organizational change. He also works closely with some of IBM pioneers in the emerging field of Brownfield (see Section 4.5.3.).

Appendix C – Empirical Data

1. Written Answer for Case Study – Large European Bank

Interview Questions:
Introduction Questions:

1. Company name:
   IBM – w/ experiences from a large European bank (Wealth Management)
2. Working position:
   Client Technical Advisor / IT Architect
3. Duration of employment at the company:
   9 years IBM. 6 years in SOA project
4. Do you want your answers to be treated confidentially?
   *a.**Yes** , please. IBM can be referenced, but not the customer.*
5. Has your company */ customer* succeeded conducting migration from legacy system to SOA?
   *a.**Succeed** the customer project had been successful with flying colors.*
   b. Failed
   c. Still in progress
6. When did the company adopt SOA?
   Back in the year 2000 – proprietary SOA with own transport protocols in XML, and then the infrastructure on IBM z/OS systems was defined until 2002.
7. Can you provide a short description of the company SOA environment?
   Please see attached high-level operational model.
8. Why did the company decide to deploy SOA?
   The customer needed to renovate the core banking systems. The legacy systems were designed as typical silo-applications and banking functions were scattered redundantly across the silo-applications. The goal was to structure the banking functions in components, representing a unique set of functions and representing them as services. The goal was to implement each function once and allowing reuse for all other components by service invocations and presenting all public services to the distributed front-end systems.
   a. What benefits did the company expect to attain?
   With loose coupling of the components amongst each other and to the distributed (frontend) systems by service invocations (runtime binding), the goal of more flexible function representation and faster time to market of new functions was expected (and achieved to a large degree).
9. Who have been responsible for the validity of technical implementations of the project? (Choose more than one option if necessary.)
   a. CEO business driven, business value.
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….
   a) The banking operational system renovation was clearly a business-driven program. It had various business success factors defined, which had been used as the criteria to evaluate the delivered technical implementations. Those were in the areas of real-time processing, CRM and reporting.

General Questions:

1. How successful has SOA adoption in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
   The legacy systems had been integrated into the service infrastructure in two ways: 1) The legacy front-end systems had been rerouted to a switch, which passes each message either to the LS or to a new service that had been implemented on the new system, but returning the result in the old LS fashion. 2) the legacy system provided to the new back-end systems with a service wrapper. This re-factoring approach enabled a step-by-step migration of functions and allowed a renovation, which replaced only the LS, which had a business case. Others still remained operational within the wrapper.
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each

a. Potential of legacy system
Good application structure of 25+ year old legacy systems contributed to success - it pays off to do systems engineering, even if eventually for sunset of the application
b. Strategy of migration
Re-factoring approach is essential. I do not know any other successful approach in a large scale SOA renovation. However, users do not see progress for a longer time.
c. Governance of SOA
- Business and Application Architecture must define the success criteria (business value) of the SOA and define the unifying and simplifying aspects of the various projects. IT must concentrate on NFR (non-functional requirements) being met (security, auditability, authenticity of messages, performance and throughput, being able to monitor and to operate the solution).
d. Business process of the company
- Is less critical in a re-factoring approach.
e. Budget of conducting migration
Legacy systems can open surprises for the budget if the systems are not well maintained and not well understood (anymore). The program must be divided in several phases, where each phase is vital for itself. This allows to stop and continue later, when budget allows.

3. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
Service orchestration was difficult to manage. The projects provided single services in single components and the end to end flow had been tested late in the lifecycle. This created challenges in proving the viability of the solution before going life as the test cases usually did not meet the system dynamics of a productive environment. This required often some fire-fighting of problems in the production environment (see NFR).
4. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)
Application development: egacy developers had been used to develop silo applications. Now facing small component solutions with many service invocations was too abstract for them to judge the technical vitality of the solution as they had only the responsibility for a small piece.
Infrastructure development: The service layers for transportation and routing had initially not been mature enough to provide the required performance and scalability. This needed additional rework. Lack of SOA products on the market based on industry standards to provide mature levels (NFR qualities missing). Proprietary design required
Data transformation: Huge problem as XML transformations are costly and you need to ensure that you do this only when absolutely necessary (once in an end-to-end flow). In a re-factoring approach, there is also massive data transformation effort from LS formats to new formats. It requires a mature ESB (Enterprise Service Bus) to do routing, transportation and transformation. Do not believe, that the industry standards and the product standards are sufficient. You need a lot of shortcuts (behind standard facades) to achieve the required performance and stability and scalability. You are in a comfortable position, if you have all your SOA service components hosted on a large enterprise server (like IBM z/OS with Parallel Sysplex capabilities) to be able to scale the performance and throughput.
Other: Service reuse was not as high as originally envisioned as the requirements changed on the fly. Workload Patterns of the production systems created unpredictable peaks (or hard to simulate). Security makes it complex, transportation protocols, which ensure that a message is not compromised (changed) are hard to find. If, then mostly point-to-point.

Business perspective:
Interviewees: One or a group of business managers involved in SOA migration project
Factor: Business Process

5. How strict was the business process of the company towards the IS legacy architecture change?
With a re-factoring approach, you are able to control this. This ensures that the business value of the application remains intact and/or is increased. However the IT-value of the application is deteriorating until renovation is complete (cost of IT is temporarily higher as parallel efforts exist).
6. How dependent was the business process of the company on the IS legacy architecture? Reason for change.
See above.
7. How far have you considered the requirements from potential service users?
Not enough. Especially service re-use was a challenge as the NFR of the second user might have been totally different from the first user and the first did set the solution design.

Factor: Budgeting

8. How far has initial budgeting affected success in migration of legacy system to SOA?
   Initial budgeting did include the service wrapping. But with the subsequent replacement of the legacy code behind the service layer, the surprises began.
9. Can you provide me with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?
   The budget for the initial phases had been met. The solution created additional business value. Remaining work is now deferred and replaced step by step when a business case exists. I cannot tell you the overall budget. But it is several hundred people over 5-6 years plus new IT infrastructure.

Technology Perspective:

Interviewees: Infrastructure developers, Application developers, Service providers.

Factors: Potential of Legacy System

10. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
    Sorry to stress one word again: Re-factoring makes the difference.
11. How do you measure the feasibility of converting a set of components in legacy system to SOA?
    The re-factoring part with service wrapping of the legacy functions is the easy part. When you want to completely replace the old code, then it starts being tricky: You need a detailed understanding of the business logic of the legacy application and this is hard to achieve, if the original developer is not there. Sometimes the only documentation is the source code. Here, application modernization analysis tooling can help to get an initial picture. But it is often based more on experience than on measurements.
12. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
    If the legacy applications are well defined and well structured with various abstraction layers for integration and if they behave more or less to pre-defined patterns, then it is much easier as if you have a zoo of undefined, strange animals. You are in a comfortable situation, if you can make changes in the legacy system before the migration to keep the target system simple.
13. How far has dependence of legacy system on commercial product affected the migration of legacy system to SOA?
    You are better off, if you determine this up-front. You are not in a comfortable position, if you need modifications to a COTS (commercial, off-the-shelf) product and this is the last thing required before you decommission it. The vendor might be rigid.
14. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    This is the only challenge in an enterprise-scale migration. Everything else is peanuts.
15. How far did you estimate the cost, difficulties and risk when measuring the potential for re-use of legacy system?
    Your business user might not see a result (benefit) for a longer time, but already paying the bills. This needs well-crafted business cases and managing the expectations. IT people are usually not good in this. They raise expectations.
16. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for migration to SOA? (Prioritize them from 1(most important) to 8(least important) and leave a cross × next to the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required
    e. Reusability factors
    f. Service Abstraction
    g. Service discoverability
    h. Code Quality

    All of them are required and all of them are crucial. I am hesitant to give a prioritization. I would not be comfortable to leave any of them out. Now, I could pick b) and h) as the ones you need first to make a reliable plan. If you don't have this, you better don't start. Then you have to create it upfront.

Factors: SOA Governance

17. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    Availability, throughput, performance and all the interdependencies of all components.

Factors: Strategy of Migration

18. What migration strategy/ technique did you choose? Why?
    Re-factoring and then adding new functions afterwards. As this allows parallel runs of the LS and the new system and you can do record/replay black-box testing before you go live with the new system.

Thank you for your time and participation in our research study!
If there is any further questions would arise, is it okay if we get back to you with the questions?
Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.
Quality of the questions:
The quality of the questions is very high as you challenged me to provide all the essentials that I know about SOA and legacy migration. And I think I know a lot of this.
How precise.
Your questions are quite precise. It shows that you are familiar with the problem area. I needed not much explanation from your side to make head and tail of it. (Hoping that my answers are also comprehensible.

2. Transcription 1 for Case Study – Large European Bank

Interview Questions:

We started the interview by introducing ourselves. Norbert checked with us if we were both Lund University students. He also mentioned that he was an IBM SOA architect and advisor. He had been advising the customized financial services industry especially on call waiting systems and call waiting renovations which were one of his specialties.
He mentioned that he had been involved a large project with a SOA approach in a bank as an architect from IBM. He insisted that the name of the bank had to be left undisclosed in our published work and he asked us to refer to it as "a large banking system". They, in this project, had replaced every legacy in a call waiting environment during the past ten years. He mentioned that this bank had a very different line of business, including retail banking and investment banking both of which had already gone through extreme renovation.
In the meanwhile, he also wondered how we could reach for him. We answered that we had the chance to learn about him from one of our seniors in Lund University called Annika Petterson. Norbert could of course remember her and her thesis work.
He then went back to the case of the bank and mentioned that their renovation had to do with SOA but had nothing to do with SOA standards. When they started, SOA had been rarely defined. They, in their approach, had defined services with XML but not as web services. He mentioned that a large part of the shifted section in the project was in XML format but they were not related to web services or web service registries and repositories. He of course insisted that equivalences of all of those existed in their adopted SOA. Norbert said that the bank's largest SOA implementation started in the year 2000 and by 2001, all the transport protocols had been described so they had to deal with it in the way he mentioned.
Since he had already had a chance to have a look at the interview questions and areas, he needed to check his interpretations of them with us.

Introduction Questions:

1. Company name: *IBM with experiences from a large European bank*
2. Working position: *IT architect*
3. Duration of employment at the company:
   It has been 9 years at IBM and with 6 years of it in the bank's SOA project–It has been 3 years for designing and developing SOA and 3 years for improving the performance and its stability since it was a large project.
4. Do you want your answers to be treated confidentially?
   a. Yes , *Since he has not asked for any permissions from their customer to disclose its name*
   b. No
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeeded
   b. Failed
   c. Still in progress
6. When did the company adopt SOA?
   They started in the year 2000 –To be more specific, they first had a proprietary SOA with their own transport protocols in XML, and then the infrastructure was defined until 2002. By the year 2002 their first application had been written being supported by that SOA infrastructure.
7. Can you provide a short description of the company SOA environment?
   First of all, there is an environment called Map Multi-Channel Access Protocol. Actually they decided to run their banking system on an IBM ZOS environment. You know what that means? On an IBM mainframe. Actually at first, the decision was not for SOA, the decision was to pick a new core banking system in which each function was only implemented once. So it was a component strategy. They developed an application

strategy to develop each component only once. Then in order to make this function available to the whole enterprise, you need a service architecture, right?
The bank had their legacy systems in 50 different areas where interest calculations happened. For example, when you introduce and make a new product, then you have to go through so many applications and make changes to these calculation modules. This is why we have to have each application only once. This gives us speed to market new products and have the IT systems support this. This was the driving force for this new banking system and when you have interest calculations only in one point, you have maybe 50 different applications which all need interest calculations, for example, you have a savings account. By the end of the year, somebody has to calculate the interest, right? If you want to have mortgage products, you know when a customer needs to buy a house and needs some mortgage, you need some interest calculations. On your current account, by the end of the month, you want to receive interest if you are in the black and you have to pay interest if you are in the red. That is the standard story probably. All these calculations, the bank decided to do it only once.
So we have one component but with so many application. You cannot just.. In the old days, you could not link or edit all these modules successfully. Actually it was about run-time binding and loose-coupling. So first they had a component strategy, run-time binding, loose coupling, and this invented the services for them. And then they created these services and the services were only implemented once. And all these business logic for the business main process are all hosted on IBM mainframe. They needed access from all the various front-end systems to do that and then they created a service protocol, much like web services to make all these java based applications access to this mainframe. And this is over an XML protocol which is very close to SOA. It's proprietary and then on the mainframes, each of the components also used the same transfer protocol so that one component can use services from another component. This was what we did as the final SOA implementation. So this was a bit…. There are services being made available in a distributed environment to be involved and then on a central enterprise system each component also works with different web services. So it was a run-time binding, loose coupling concept.
The interesting thing is that the IBM mainframe base core banking system. It was implemented in COBOL and DB2. So the COBOL programs are exposed to the outside, not with web services but with something very equivalent. And when they started in the year 2000, they felt like java was not mature enough at that time to host the core banking system, not mature enough and providing not enough performance, ok?

8. Why did the company decide to deploy SOA?
   It's the loose-coupling concept, simply having each function being implemented only once…Business logic to be implemented only once
   a. What benefits did the company expect to attain?
   Flexibility, faster time to market, IT not being a …holding up the process, you know as just an example, introducing new products may… it took them 18 months to have the programmers support the new functions and to do all the development and today they can probably do this in 3 days because they have more dynamic features, they have certain base services and one function only once also means a high reuse of existing services. This project finished 2 years ago.
9. Who have been responsible for the validity of technical implementations of the project? (Choose more than one option if necessary.)
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….
   That's a difficult question. Many people. It was a huge project of the complete modernization of the IT systems and there was of course the program manager. Usually they needed the project from the executive board of the company so CEO would probably be the final decision maker to say "yes, this is what we need." It was not a decision within the IT department. It was a business-driven project. They were not really responsible for the validity of the technical implementation but they were very interested that there was a business value behind it. So it was not a project just to simplify the IT or to give more IT value. It was a project or a large program to give more business value to the IT applications.

General Questions:

1. How successful has SOA adoption been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
   First of all, the approach was to create a new banking system which was completely new but the company service-wrapped all the legacy systems initially. That means that all the legacy applications are now parts of the service transport protocol. Let's say on a distributed server, you have a java application and this java

application needs to access something on the host. We had in the past, integration problems. Now they can use this service layer. They can even access legacy applications which are service-wrapped.
Second what they did is they partially or step by step, removed the legacy code so it's a new developed code. The approach was a refactoring approach. Do you have any imagination what a refactoring approach is? What they did is first they rapped the legacy code so they had a service to access the legacy object. Because in the old days you probably sent a file and then you got another file back. Let's say what your new interest being calculated for your accounts so you would get all your account balances and all the detailed transactions in a file and you would get a file back with the results. Now service-wrapping means that you have a web service, let's talk about a web service now. Forget about this proprietary implementation. You do the same thing but you still have your old code. Now you define a new service, you have a new application using the same service. So basically the service surface remains the same and your end users and all your distributed applications do not see any difference because the behavior is exactly the same. And then when it's successfully finished, you can exchange the new functionality but you have to avoid big bang changes. Because you cannot change all your …let's say you have a service. It is used by 50 different distributed systems. You cannot change all the 50 systems at the same time. what you do is that you define a compatibility mode for all the 50 ones and then 49 are using the compatibility mode and the first one is using the new one. And then the second and the third. And these can us maybe new functionality an the old ones still receive the old service and gradually over time you change all of your 50 applications so when you introduce new functionality mode, you are already trying a new mode. This does not disturb you application landscape. If you have 600-700 applications, many of them being dependant of all these refactoring approach. It is also the right application to introduce SOA. And this is what most of the people forget. The problem with that is, your users don't see any benefits for 3-4 years until you finally establish the SOA infrastructure, the transportation protocols and … because you have to keep them in parallel with your legacy systems. And this is an important area where most of the SOA projects in the past failed. Because they were against creating islands. I'll give you a little explanation on this reflecting approach.
Yes, it has been successful but there's always room for improvement. You know you solve it to a certain extent and then actually when you are finished, you have to start all over again. In the project I was involved, actually the services had been too fine gradular?!! And in certain areas there was high reusability but there are also areas where a service is used only once. Probably over the next years, the governance will change to some extent so it was partially successful but it was not fully successful though successful enough to give the business enough benefit.

2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each
   The organizational and technical factors can be important but the strategy of migration was key and very important. If you do it wrong, you will fail. If you do it wrong, you will fail. What was also very important was the business process of the company that you have to do this refactoring approach. Don't do all the things at the same time. Ideally you have to start with the IT systems. You have to first establish an SOA infrastructure. During that time no business user can see any benefits. When you do it right, they won't see any changes for 2 years. The systems still behave the same. But under the cover, all the IT people are working hard to create a new service-based architecture that can enable changes later quickly. Then usually the SOA projects start and then they promise too much to the business. When you say I wanna' give you SOA, let me work for 2 years and maybe pay me a lot of money but you won't see anything getting better, businesses are probably not willing to do that. But you have to think much more long term. And then you see from this bank customer, it was a 6-year journey. For the first 3 years, the customer did not see anything. Nothing was changing! They had green-screen applications and 3 years later the still had green-screen applications. Something dramatic was changing in their core banking systems but nobody saw anything. But I call this 'heart surgery'. But most of the SOA projects do a cosmetic surgery. You know, they are trying to make it look nice on the surface but then they do not have enough power to go back into the inside systems and then when you do heart surgery, you know, the patient has a new heart, but you don't see anything nice on the outside. The patient might even look more frightening to somebody so your business applications need a deep understanding and patience. They say: 'Ok, first we have to increase the IT value of the system before we can take the next step and only provide the business value'! This happens a lot!!
   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration
3. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?

Very close. It has not so much to do with the services itself but the fact that the project decided to bring functionality in components so actually your internal process is an assembly of many different services, sequences of services in a kind of a workflow but also each service depending on many sub-services or child services. This complexity was not enough managed because each sub-project was only delivering one component. Imagine in a workflow you want to have an end to end response time of sub-seconds. It should be less than a second. So everybody tried to be sub-second. And when you looked at the entire process, you had maybe 10 services involved and then you were wondering why the service took 9 seconds to respond. But they all did not know what else was involved, you know. But they anticipated that the other services don't take any time. Actually there was good governance but by focusing on components and single functions to be produced, there was not enough focus on service orchestration.

5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)

Too many services because everybody wanted to have its own. Yeah, getting the reuse somehow organized. When you create a service application, you try that the integration layout, always the data is that you need. Let's say you have an event which requires all the different files from somewhere and then does the sort-merge and then doing some process. This might be a very old style service application. In a service-oriented application, you would want to have the main stream business logic doing such a processing that all the related data that you need, you just provide them over services. Let's say you have some sub-transactions coming in from the market into your banking system. It could either be a file with process, it can also be event-driven, let's say you have managed, you know you have a message and you just throwing the message to a distributed system and then you have either one thread or you have several threads to do the processing. But what you do is you do a lot of validation verification enrichment processes before you do your actual processing, right? You wanna' look up in the database table, it could be the company, when it comes from a stock market, somebody wants to buy IBM shares so you look up valid codes in an IBM system, 'Oh yeah, IBM stock pro is from New York..' whatever. So for these kinds of validations, you look up the code and then bringing in the long description. All these are not done in a preparation state. When you code that, you need to define certain service levels for each of the services. First of all, what would be the expected response time. what would be the availability of this service when it is on a remote server and what would be the volume peaks you know. When you say, 'ok, yesterday I had around 1000 stock transactions, now I have 10,000! What can I do?' Then you scale your application. I have 10 threads running in parallel for the messages coming in. now on your server I need 50 parallel threads to do the processing but then the underlying services might not be able to be scaled in the same way. Now the scalability is hard to design that how much of this you need and how dynamic or static it is. In the old days , it was only static during reading the file and then when it was not fast enough, so they split the file into pieces. And we are running two batch files. One process in the first file and the other processing in the second file do this is quite difficult and also the underlying database access traffic then got very unpredictable. When you design making applications for trading systems, speed is everything. Speed and being flexible to respond to web changes and peaks. I told you the first year I was involved in designing these things and in the other 3 year, I was involved in increasing the performance. This was basically the second part. So creating an SOA application environment and also coring the non-functional requirements can be a challenge. Security is also a big problem. It is also one reason why this customer decided to store all their data on the mainframe that has a big DB2 database underneath and then putting the main processing components on the same mainframe. Because it is not like the Unix server. It scales much faster and also it keeps the data on the date system. If you have distributed systems, you always have the networking in between.

The network is difficult to scale because each network traffic is a serialization. The second, if you want to make it secure, then you have to do a lot of encryption. But if you are a bank which says that I cannot expose customer names or things like that, there would also be another organization that has to deal with security. It's a big extra effort because of the service being transported on the network, an XML message is not really secure. It's not only people not be able to look at names and other data. There's always an area where data can be manipulated, though even if everybody can read it, but make it read only. How can you make sure that your management message you that the receiver still receives the original message that is not compromised.

Have you heard about cloud computing? This is difficult to ensure that security can be 'nobody should read it or make sure that nobody compromises my data.' And for both, you will have to encrypt it. And then this is extra effort which we didn't go through.

N a web service protocol, transactional consistency, that is by the way also another reason to centralize the SOA environment, is not so long part of the web services protocol and security is also not so very long. Have you heard about security in web services? Transactional consistency is a security topic when we talk about web services. It is possible today that maybe the implementation that exists today are not in all cases efficient and effective enough to solve the problem. This is also what I put in for number 4.

Business perspective:

Factor: Business Process

6. How strict was the business process of the company towards the IS legacy architecture change?
   Yes, there are always two ways of doing it. I told you already about the refactoring approach. But when you do the refactoring approach, maybe your business for a long time didn't see anything. If you don't take his approach, then you'll run into a problem that the changes in your IS legacy architecture are not noticeable to the customer. They either see something bad or they see nothing happening, this is the choice..ok? the only thing I can tell you is that refactoring approach works as long as your business tolerates this. Then you avoid exactly what you wanna' ask him. None of them is really a happy answer. The happy answer would be 'I can make any change very quickly but I don't the reason.' There's a new buzz word called 'brown field development'. And strategically it is exactly what our species is doing..computer science people.
   SOA species we had to go away form green field development to starting from scratch and I think they call it brown field development. That's an ugly name, I don't like it. But you are creating something and taking the existing IT systems into consideration.
7. How dependent was the business process of the company on the IS legacy architecture?
   In my case I would say it was the reason to do something. The driver for creating a new core banking systems was basically the fact that the business process was not acceptable anymore. In terms of time to market and also in terms of supporting the new business model. The bank had an exchange strategy to go from a local bank in one country to a global bank so the business process and the legacy IT systems just didn't fit together anymore.
8. How far have you considered the requirements from potential service users?
   Not enough. Because actually the first user defined it, the second user found out that it was not good enough for him, especially with the non-functional requirements. Again the second user said I need exactly the thing that we have but just a little bit quicker. The first user says ok, I need a service that retrieves the customer name and the address and the second one says, oh I need exactly the same service but I only need the name and not the address but I need it much faster. It's not realistic. Let's say your response time is 10 mili seconds with only the name and it would be 15 mili seconds with the name and address. The second user says I need a separate service for that. Then the other one says: 'Don't change it, I am going to take it to production tomorrow.'So there was no imagination of these dynamics, you know, like when you create a service, then you, even if you have 500 users but you decided you don't have them all in mind, and I think this was a bit of a problem.

Factor: Budgeting

9. How far has initial budgeting affected success in migration of legacy system to SOA?
   Actually what happened was that the project was developing new code with new services. But also to save time, they did not rewrite legacy services but they were just service wrapping them. And the problem today is with the wrapped legacy systems because they worked too well so for initial success it was good, now they nearly under-estimate it in terms of budget efforts and so on. Still at some points you may want to take away the service-wrapped code and write new code. Service-wrapping is quite expensive and quite complicated, you know. A lot of format changes, you know you have XML to be converted into COBOL structures and then you have a lot of look up tables, it is actually a lot of various different data formats. You have to provide it then in the right format as the legacy systems can digest it and then process it and then when it comes with the results, then you will have to take the result and change it and it's actually very complicated and also maintaining the legacy application logic and source code also take some time and we see probably 30 percent of the functions inthis banking system that still use the legacy code, by today they wanna' have it all replaced. We kind of underestimated it and also when you start wrapping, you only see the service and they don't see what's behind and the things behind can be very very complicated and very difficult to maintain.
10. Can you provide me with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?
    I cannot provide you with the total cost, but it's a huge number. They were kind of on target. So there wasn't really a budget problem. The only is that there's still such a legacy code lift. They thought they would be faster in getting rid of old transport protocols and connection protocols and things like this. For example they still use COBA protocols: Component Object…whatever. It's an old communication protocol. They are getting rid of it quickly because it's still existing.. because you can only estimate when the large piece is gone, you always underestimate what it really takes. It's always that your new system creates business value as early as possible, it's not so much a problem you can somehow survive.

Technology Perspective:

Factors: Potential of Legacy System

11. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?

Yes, but it was kind of a mix. When you run this refactoring approach, it's a mix of creating new functions and adapting the legacy system that it can survive in the new world. The refactoring approach sometimes means more change in your legacy systems than in the new system.

12. How do you measure the feasibility of converting a set of components in legacy system to SOA?
    It is experience. It is difficult to measure.
13. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
    You have to be very aware of your legacy systems. If you do not consider this, you might fail. You have to tailor your new system that it works very well with your legacy systems together. But it also makes it complicated because your new system cannot be as simple as it could be and one decision can be that you make a lot of changes to your legacy systems that keep your new system clean and small and efficient. However, this is an organizational problem if you still have all your application programmers of your legacy systems. Then they all fit and they know about the system, then you can do it. If the resources for the legacy systems are short where you have more maintenance than developers for your legacy systems, then it would be difficult because of that.
14. How far has dependence of legacy system on commercial product affected the migration of legacy system to SOA?
    In the environments I worked in, we tried to not have these dependencies but when you have the dependencies, it is difficult.
15. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    Yes, of course
16. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system?
    It was an important point (potential for reuse). They actually changed the legacy systems to be ..they defined minimum criteria for legacy systems to make it compatible with the new SOA and this means changes to the legacy systems.
17. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for migration to SOA? (Prioritize them from 1(most important) to 8(least important) and leave a cross × next to the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required
    e. Reusability factors
    f. Service Abstraction
    g. Service discoverability
    h. Code Quality

    It has to do with the level of documentation. Level of documentation can be a problem. In service abstraction and service discoverability, what they wanted was not that they wanted it to be able to put these legacy systems into the new defined workflows. They defined new workflows that ensured that certain CRM databases had been updated at the same time. They were looking for which application was easy to achieve and that was a decision factor to keep the legacy system and service-wrap it. It was not only to achieve. This was a decision to rewrite that earlier. So they looked into the things which were compatible with the new world easily and then they left it and made some changes and the other things they had to make radical changes and make a new design.

Factors: SOA Governance

18. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    Already explain before

Factors: Strategy of Migration

19. What migration strategy/ technique did you choose? Why? *Refactoring approach. Already explain before*

Thank you for your time and participation in our research study!

If there is any further questions would arise, is it okay if we get back to you with the questions?

Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

3. Transcription 2 for Case Study – Large European Bank

Interview Questions:

He is attending advising customer information services industry especially in core banking system and renovation. He has been involved in very large co-banking renovation, which has SOA approach. This bank has a lot of co-banking renovation over ten years. This bank has different many lines of business. This bank has

retail banking, investment banking and other lines of business. The retail banking system has gone extreme renovation over some years. He has working in this project and supporting this customer from IBM side.
He mentioned that this big renovation is related with SOA but nothing related with industry standard in SOA because when the customer started the web (SOAP) application, it is well pre-defined. This is known web service. It has proprietary implementation related to service. There are services related with XML, envelope, service payload in XML format. It is not related to web services, web services registry and repository. There are services being sent, the largest is maybe SOA implementation for a bank. In 2000, all the transport protocol has been distracted.

Introduction Questions:

1. Company name: *IBM with experiences from a large European bank*
2. Working position: *IT architect*
3. Duration of employment at the company:
   9 years IBM. 6 years in the SOA project – 3 years designing and developing it and 3 years for increasing the performance and stability.
4. Do you want your answers to be treated confidentially?
   a. *Yes*
   b. No
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed *yes succeeded*
   b. Failed
   c. Still in progress
6. When did the company adopt SOA? *Started in the year 2000 – proprietary SOA with own transport protocols in XML, and then the infrastructure on IBM z/OS systems was defined until 2002*
7. Can you provide a short description of the company SOA environment?
   Yes, he will write something, first of all, the environment we called ***map logic channel SS protocol??*** *It is known as IBM mainframe. It is new core banking system which each function is only implemented once even the component strategy, business component and application component. Since each component implemented only once, we need service architecture in order to make the component available for the whole enterprise system. For example the bank has 15 different areas when interest calculation happen in the legacy system. When we introduce the new banking product, we have to go through so many applications to make all this changes in the interest calculation module and introduce it. But using SOA, we only introduce only once. It can increase a speed and the IT system supports this. This is called the driving force for new banking system. Thus we have one component with used in so many applications. We also considered run time binding and loose coupling in this service. And then they created the services. Then All business logic or business bank processing are hosted in IBM mainframe, we need access from all vary extracted system to do that. Then we created service protocol like web services. It is over XML approach protocol and it is proprietary.*
   In mainframe, each of the components use the same transfer protocol so that one component can use services from another component. Thus the services are available in distributed system environment and in central enterprise system. The IBM mainframe uses COBOL and DB2.
8. Why did the company decide to deploy SOA?
   Business logic to be implemented only once
   a. What benefits did the company expect to attain?
   Flexibility, has more dynamic function with high reuse of existing services
9. Who have been responsible for the validity of technical implementations of the project? (Choose more than one option if necessary.)
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….
   Many people involved because it is huge project. CEO and the executive board probably is the final decision maker. They are interested with business value behind it, not the IT because it is business driven project. The project manager is responsible for the validity of the technical validity but he is interested with the business value behind it.

General Questions:

1. How successful has SOA adoption in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)

First, to create a new banking system, which is completely new, but the company's service wraps all the legacy system initially. It means that all legacy applications are part of the service transport protocol. For example, you have java applications then these applications need to access something in the host. Now, they can use service layer and they can even access legacy application function. What we need is step by step, we removed legacy code with new developed code. It used refactoring approach. We read legacy code so we have service to access the legacy function because in the old days, you send the file but maybe you get the file back with the result. Now, you define a new application using the same services. Basically the service remain the same, and the end user and the distributed application do not see the difference because the behavior exactly the same. And then if successfully finish, you can extend the new functionality but you should avoid the big bang changes because you can't change all your services used by 60 different distributed systems at the same time. When you introduce new functionality, it always runs in the compatibility mode. This will not disturb your application landscape, even for hundreds applications. The problem is the users do not see the benefits until you finally established the SOA infrastructure as the whole system. The reason is we have to keep them parallel with the legacy system and this is the important area, which as the reason why most past project in SOA has failed.

Yes, it has been succeed in reusability, agility, efficiency and productivity. When you have finished you have to start over again. In certain area there is high reusability but there are other areas which used the component only once. It's successful enough to give the business benefits.

2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each

   Strategy of migration is the key. It's very important because if you do it wrong, you will be failed. Also important is the business process of the company. You should do the refactoring approach. Don't do all the things at the same time. You have to start with the IT system by establishing SOA infrastructure. During that time the business user didn't see any benefits. When you do it right, they don't see any changes about two years because the system still have the same behavior. The IT persons were working hard to create new service based infrastructure and able to changed rather quickly. Usually the SOA project goes and starts and then promise too much to the business. But if they don't promise to the business, they don't get public. You have to think much more long term. You can see in the bank customer, it was 6 years journey. In first 3 years, the user didn't see any changes. The customer still had green screen application. Something dramatic what changing in the core banking system but nobody saw it.

   Most SOA projects do cosmetic surgery. They try to organize on the service, but then they don't have enough power to go back into the entire system. The business people need to deep understanding the benefits. First, we have to increase the IT value of the system before the next step for proving the business value.

   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration

3. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?

   Yes, very closed. It has not so much to do with the services itself. But the project decided to bring functionality into component. Actually, it is assembly of many different of services, like work flow. Each services depending on many sub services. This complexity was not enough managed because each sub project was only delivering one component. My component is fine and the other one should be also fine.

   They actually know with the good governance by focusing on component and single function should be provided. There are not enough focuses on the service orchestration.

4. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)

   The challenge is too many services because everybody wants to have it all, getting the reuse somehow organize. When you create application, what you do is you try the integration layer service. You try to integrate all the data together what you need, such as you have web shop require different file and doing SOAP merge and doing some processing. In service oriented application, you have the main stream business logic doing certain processing. They are related the data what you need. You just provide over services. For example, you have stock transaction coming in from the market into your banking system. It could be in a file and process develops or it can be message from broker. You do a lot of validation, verification and process in your processing. Then you do look up in the database table. Look up code and bringing the long discussion is not done in the preparation step.

   The underlying services are not able to be scaled in the same way. The scalability is hard to be designed, how much what you need and how dynamic it is. The underlying database access traffic is very

unpredictable. When you design banking application for trading system, speed and being flexible to respond for web load changes are important. That was basically the 2nd part of 3 years. Create SOA application environment and also covering not functional requirement can be a challenge. NFR performance throughput. Also security is the big problem. It is also reason why the customer decided to store all the data in the mainframe. So they have big DB2 database. And then they put the main processing component in the same mainframe. It is much faster and also keeping the data in the same system. If you have distributed system, you have always the network in between. The network is difficult to scale because each network need serialization. To make it secure, you have to do encryption. Using the message, it can be always in the area that data can be manipulated. How to make sure that the data is not compromised.

That's the big problem with cloud computing. It is difficult to ensure that no body read and compromise the data. For both of them, you have to encrypt it. In the web service protocol, transactional consistency is also important. Transactional consistency is also the reason why conceptualize SOA environment. Transactional consistency and security are not so long part of the web services protocol.

Business perspective:

Factor: Business Process

5. How strict was the business process of the company towards the IS legacy architecture change?
   Yes, there are always two ways to do it. When you do the refactoring approach, the business for the long time doesn't see anything. If you don't take refactoring approach, the changes in IS legacy architecture will impact your customer. Refactoring approach works as long as the business tolerates it.
6. How dependent was the business process of the company on the IS legacy architecture?
   Creating new core banking system what basically affect business process was not acceptable any more, in term of supporting the new business local. Extension strategy for the local bank in one country to be global bank, the business process and legacy system didn't work together anymore.
7. How far have you considered the requirements from potential service users?
   Not enough. Especially service re-use was a challenge as the NFR of the second user might have been totally different from the first user and the first did set the solution design. For example the first want to retrieve customer name and the address. The 2nd need the same service but only the name, not the address. Thus the 2nd want to be quick response.

Factor: Budgeting

8. How far has initial budgeting affected success in migration of legacy system to SOA?
   The project was developing new code with new services. But also to save time, it's not rewrite legacy services but using service wrapping. The team really underestimated it in term of budget, effort, etc. The service wrapping is quite expensive and complicated. You have a lot of form changes, such as XML to be Cobol structure and you have a lot of look up table. Beside that you have a lot of very different data format then you have to provide the right format to the legacy in order to be processed by the system and you will get the response back. Maintaining the legacy application logic and source code also takes time and difficult to maintain. 30% of the function in the banking system is from the legacy code. By today all are replaced.
9. Can you provide me with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?
   The total cost is huge number. There is no really budget problem. It is still on target.

Technology Perspective:

Factors: Potential of Legacy System

10. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
    Yes we use most of the components. Using refactoring approach, it is kinds of mixed creating new function and the legacy system.
11. How do you measure the feasibility of converting a set of components in legacy system to SOA?
    It is experience. It is difficult to measure.
12. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
    You have to be very well in the legacy system. If you do not consider it you might fail. You have to create the new system and check with the legacy system together whether work very well or not. It can be complicated. When you make a lot of changes in the legacy system and keep your new system clean, small and simple. However it's organizational problem if you still have old the application programmers of the legacy system and all of them are fixed and they know about the system then you can do it. If your resources imported the *legacy system are short, you have to more maintenance than developer of the legacy system. It could be difficult.*
13. How far has dependence of legacy system on commercial product affected the migration of legacy system to SOA?

Try to not heavy dependence with the commercial product, because if it's heavy dependence, it can be difficult.

14. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    Yes, of course
15. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system?
    Define minimum criteria of the legacy system to make it compatible with the new SOA.
16. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for migration to SOA? (Prioritize them from 1(most important) to 8(least important) and leave a cross × next to the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required
    e. Reusability factors
    f. Service Abstraction
    g. Service discoverability
    h. Code Quality

    Level of documentation can be a problem. In service abstraction and service discoverability, they want to be able to put the legacy system into the new defined work flow. They defined new work flow to make sure that the certain databases are updated at the same time. They looked at which application was easy to achieve. It was the decision factor to keep the legacy and service oriented. If not easy to achieve, so they will rewrite that earlier. Compatible with the new world easily and make some changes, the other thing is make radical changes.

Factors: SOA Governance

17. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    Already explain before

Factors: Strategy of Migration

18. What migration strategy/ technique did you choose? Why?
    Already explain before

Thank you for your time and participation in our research study!

If there is any further questions would arise, is it okay if we get back to you with the questions?

Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

4. Transcription 1 for Case Study – Skandinavian Airlines System (SAS)

Introduction:

1. Company name: *SAS*
2. Working position: *Development and maintenance coordinator, Strategic IT Manager*
3. Duration of employment at the company: *7 years*
4. Do you want your answers to be treated confidentially?
    a. Yes
    b. *No*
5. Has your company succeeded conducting migration from legacy system to SOA?
    a. Succeed
    b. Failed
    c. Still in progress
6. When did the company adopt SOA? *We started on the 90s. in 2003 we went for web services.*
7. Can you provide a short description of the company SOA environment?
    We do not have a SOA project. We implement web services in different projects. We were not trying to replace the existing legacy systems with new systems, we were trying to use or reuse them, in fact to integrate with legacy systems to use their functionality. We have different kinds of web services in SOA, in .NET. They are mostly in .NET platform. We have both internal and external web services.
8. Why did the company decide to deploy SOA?
    a. What benefits did the company expect to attain? *Mainly for faster time to market and feasibility.*
9. What role has each of the following people played in the implementation and success of the SOA project?
    a. CEO
    b. Project manager
    c. Programmer
    d. System Architect

e. Other party, which are ….
Architecture department and systems architects. All projects have a system architect designing the system.

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
   I don't have any numbers on that. We have our organization application…very much reused in different projects…however we would have wanted more reusability.
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
   Technical issues and organizational issues are very hard areas to control in terms of cost. It is hard to see in which areas to invest in. web services are costly to produce in a manner that they are reusable. Each project taking that cost is designed for reusability.
3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration

   A web service should not be too large and not too small. It's more complicated and hard to…therefore we develop web services and also to avoid spaghetti implementation and architecture which can be hard to control. We are putting on SLAs for the web services. You can have thousands of SLAs to follow up on that. Business process has not really had a role. Web services are not related to any document specific business process. They are more developed from a functional requirement perspective.
   Regarding the budgeting issue, web services are financed by each project. Fro example if you have a project that you developed a web service for a customer to book a hotel and reservation of it, that web service should connect to the database . the database will be financed within the project. It's subscriptive
4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
   We have an architecture review on every phase of the project. We have done development in web services. When the projects are relevant to maintenance, they have failed. It is the manager who will decide for maintenance of web services. That caused failure in the early development of web services.
5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)
   The challenge is to develop a web service that can be reused. We are developing web services all the time. it could be ..reused from the beginning. Most of our strategy is to inform the architecture where existing web services are and what they do. That is a challenge for everyone to know what all the web services are and what they are doing.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
   We do not convert any legacy system to SOA. It is feasible because we have done it!!! We do not measure feasibility. Why should we do that? We are integrating with our legacy systems and it is feasible and we are doing it.
8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
   Not so much in …. However if you have any input … to market …new functionality outside the legacy systems rather than inside. To …the functionality, we are dependent on the legacy systems, …and the functionality in them. That is why we implement it…..of the LS but it is not the reason why we are developing new web services……..
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    Regarding reliability, I would say that we are using Microsoft platform….. the reliability on webservices is not as …as on the mainframe or a unix mainframe which has a much higher reliability. We do not have security measures right now ……..when we expose our system functionality,……security missions are

more important to us. That we do not have a general …….. for exposure or……more than…..business perspective. The business perspective is not so risky for us. As for performance, is it as good as maintenance? Different types of information in web services……..

11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    All our development is based on evaluation and estimating cost. The estimation of cost, risk and difficulty is a job performed by our vendors. We have outsourced our development.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required
    e. Reusability factors
    f. Service Abstraction
    g. Service discoverability
    h. Code Quality
    Number one is the reusability factor…pro-webservices……development in the LS. The second one is level of documentation. Scale of changes required as well as size and complexity of the LS are other factors.

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
16. How far have you considered the requirements from potential service users?

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?

Thank you for your time and participation in our research study!
If there is any further questions would arise, is it okay if we get back to you with the questions?
Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

5. Transcription 2 for Case Study – Skandinavian Airlines System (SAS)

Introduction:

1. Company name: *SAS*
2. Working position:
   He is a project and maintenance coordinator of SAS group. My main responsibilities are in the area of strategic decisions regarding governance of IT development and maintenance.
3. Duration of employment at the company: *7 years*
4. Do you want your answers to be treated confidentially?
   f. Yes
   g. No
   I would like to review your writing before.
   When you are talking about migration, we are trying to replace existing legacy system with the new system. We reuse them and develop new functionality with integrate the legacy system we have with web services.
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed
   b. Failed
   c. Still in progress
   Yes, it's successful. If we see the number of web services we set up now, it will be extremely to more and more complicated. We have to control the web services.
6. When did the company adopt SOA?
   In 1990's, we implemented the area of services in Microsoft without current technology in SOA. But it's the service. In 2003, the web services are developed with the Microsoft adopt.

7. Can you provide a short description of the company SOA environment?
   We have different kind of service developments. The most web services are implemented in .NET platform. We have internal web services and the external web services. So we have external companies using the services.
8. Why did the company decide to deploy SOA?
   Mainly for time market and there is reusability.
   a. What benefits did the company expect to attain?
9. What role has each of the following people played in the implementation and success of the SOA project?
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….

   We don't have SOA project. We implemented web services which are done in different project. We receive stakeholder request to do this functionality and so on. And then the projects do the functionality. The project decides a way in web services to support the functionality and the implementation.
   If there will be web services, I shall say business requirement and architecture decision is important. We can say they are the most effective in building the system. Our system architect is responsible in making decision about the structure of the system. All our projects have system architect designing the system.

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
   I don't know how to measure that. We don't have numbers to measure that. We have authentication data services. The services are very much reuse in different project. We would have more reuse the web service than we have to take.
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
   I think it's about technical issues but organization issues affect the success as well. But also they have area to control in cost. It's quite important in what area the web services used whether they can be reusable or not. It's quite hard the project taking cost on web services.
3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration

   Regarding the strategy in trend of web services and reusing the legacy system, we have architecture decision that web services must be develop and new application must be in web services. The strategy is to have SOA in our IT environment. In those areas, we developed web services, which are to be reused.
   The governance is also playing its role in the process to manage that the web services are not too large and not too small. You can develop web services only 1 logic but then it's quite complicated and hard to control and also to avoid the spaghetti implementation. But also could be heavy, there is web services which re implement the spaghetti code. It will be heavy to control. Putting on SLA in web services, it will be difficult to follow up in this service. If you have web service, you can have hundreds thousand SLA to follow up one element.
   The business process of the company is not really affected because the web services are not connected with the documents. It is more develop functional requirement perspective rather than business process perspective.The web services finance budget project, we have the project which customer can book hotel, reservation, etc.
4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
   Regarding the monitoring project progress, we have architecture review on it in each topic. We did development and development has been done in web services. When deliver development to maintenance, they have try to inform system manager they will go from internet about this web services. It has been heard failure in the progress over development new web services in their maintenance.
5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)

The challenge is how you develop web services that can be reused. Instead of developing new web services all the time, it will be good if development reusable from the beginning. The architect needs to be form the existing web services are what they do. That is the challenge for everyone to know what for the web services are and what they are doing.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA? *Already mentioned before*
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
   We don't convert any legacy system to SOA. We can say integrate the new web services into legacy system to be SOA. And this web services can be reusable. It is feasible because we have done it. We don't measure the feasibility of converting. We are integrating with our legacy system with new web services. But how do you measure it?? It's feasible when we are doing it. So I don't know how to measure.
8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort? *Already mentioned before*
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
   Not so much licensing, I would say. However they have time in market. But it has been critical factor. We develops new functionality with append to the legacy system rather than replace the legacy system. It's still reuse the functionality.
   Actually, they are connected each other. We are dependent on legacy system because much functionality in there. We have high dependence of legacy system but it's not the reason we develop new web services.
   Yes it could be the legacy system use from one company and the web services use from other company.
   Our partner, they developed our existing legacy system and they are also developing most our web services.
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    Regarding reliability, I would say they are using Microsoft platform to develop it. For the reliability, it's not that good as IBM mainframe. It's much higher reliability. We don't have security issues in developing web services because we have done it.
    Of course, when we exposed our system functionality, the security is more important to us. We don't have general/public to expose our web services in business perspective.
    The performance is good enough for our system. We have different type of information and services.
11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    All our developments are based on evaluation and the estimation cost which make cost efficient to make new development in web services.
    Yes, there are risks and difficulties before reusing the legacy system. Actually, our development is developed by our vendors. We have outsource of full our developments.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required
    e. Reusability factors
    f. Service Abstraction
    g. Service discoverability
    h. Code Quality

    I would say no. 1 is reusability factor. We are doing development in the legacy system by integrating with the web services. The web services will reuse the legacy system as the component to handle the job. This web services supposed to be reused as the component has its own characteristic.
    If the legacy system is not possible to reuse it, we can't use the web services. That would be the main issue. The second is level of documentation. If we have good documentation, it will be easier. And scale of changes is important in business perspective.
    No 1. is reusability factors
    No. 2 is scale of changes
    No. 3 is level of documentation
    No. 4 is size and complexity. If it's really complex, it will be difficult to develop web services.
    No. 5 is code quality

No. 6 is support software required
And no. 7 are service abstraction and service discoverability.

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    About reliability

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why? *Already mentioned before*

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
    We do not have our business processes documented for administrative staff.
16. How far have you considered the requirements from potential service users?
    We have interviewed our commercial stakeholders so we know where we shall focus on development of new webservices. This is to make the web services so general as possible so that we easily can create more functionality in the web services when required.

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
    One of the success criteria's of implementing SOA is to have funding enough in a project to make web services as reusable as possible. Reusability costs a lot of money up front but reduces costs in the long run. The business case for each project is negative affected by this up-front cost so there might be a good idea to put in extra funding for infrastructure costs to cover the extra costs.
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?
    No, That information does not exist since we don´t have a SOA implementation project.

Thank you for your time and participation in our research study!
If there is any further questions would arise, is it okay if we get back to you with the questions?
Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

6. Transcription 1 for Case Study – A Large Swedish Company

Introduction:

1. Company name: *A globally –known company in Sweden*
2. Working position: *Responsible for the company's internet technical platform, Infrastructure manager*
3. Duration of employment at the company: *7 years*
4. Do you want your answers to be treated confidentially?
   a. *Yes, the name of the company must be kept undisclosed.*
   b. No
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed
   b. Failed
   c. *Still in progress*

   When we started SOA, SOA was still new to the market and there weren't any mature products, so as a large company, we cannot just create something. We need a stable architecture to build upon and as that was not available on the market, we had to create it ourselves. For example the integration busses and so on, there were no busses on the market so we created our own and of course we are still living with that product of ours. But I would say in 5 years, we have replaced it with something that is out in the market instead of creating it ourselves, so in that terms, we are still in progress. When it comes to internet, we are right in the starting phase of transforming the internet into a very much more service-oriented platform. A real service – oriented platform where we also see the partners perspective outside of our company to present our services to ..because the thing we call ITF (the IT Foundation) is for the company's internal service and use only.
6. When did the company adopt SOA? *Sometime in 2004- 2005*
7. Can you provide a short description of the company SOA environment?
   If we look at the initial business cases that were the starting point for everything, we came to some initial estimation about how much this will cost, how long it will take and what benefits we would get in return. None of those three bullets have been fulfilled the way they were predicted. Almost none of the business services have been reusable, for example. That's my pessimistic side of it. On the other side, we have a very good end-working architecture with a lot of business service and a basic infrastructure in place where we have these service catalogues and …replacing legacy systems..yeah both yes and no. when you want to transform your legacy system into service-oriented architecture, it's always sort of a 10 percent of the legacy systems that somebody says oh, we don't have to transform this because that will be faced out. But

it's never faced out..so instead you will have both. In ikea for example we have this very old store system, which we call a legacy system. It was create din the late 80s and of course one of the first services that we started to create in our service –oriented architecture was a new store system. That system was very successful but still we are using the old store system somewhere in the back-end. So we are still struggling with maintenance difficulties.

8. Why did the company decide to deploy SOA?
   a. What benefits did the company expect to attain?
9. What role has each of the following people played in the implementation and success of the SOA project?
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….

   Systems architects play the most important role. Lead developers are also important in the implementation of the SOA project. Looking at the infrastructure, we can see that from the beginning we had the blue prints and the standardization department was to create the infrastructure as well as the basic rules of how to create business services or how to use development tools and all that kind of stuff, they created it and ……. And then the development team came and was about to start and obviously when you have created a base architecture without having any consumer of that, you are doing it only in theory, so when it was tested in reality, it was a lot of lack of functionality and things didn't work out as they should be. So when it comes to roles, there must be roles that connect those things together, you can't really … maybe you'll need a more iterative approach but I would say roles that can connect … is very important. CEO and people like them are not really that much involved. This is all about IT. These people are deciding on ho much money to spend to create this business value. But that has nothing to do with the implementation of it and how that is done. In this company there was a sort of enterprise architecture role at first and the system architect wouldn't come along until the next step. It of course depends on the scope of the company project. The scope here in this company was to totally change everything. …..

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)

   Reusability was not provided. The project cost a lot more than the budget. The end product is good from end-user's perspective, but on the other hand, non-SOA could also be very user-friendly. The benefits should only be seen in how to maintain or extend the system, you also need to have very clear interfaces, and as this system grows bigger, you'll have dependencies to everybody else and you'll need to be aware of what the other projects are doing because you'll need to interact with them and any careless changes could lead to a total mess. We cannot go on with a project for several years without delivering anything so that means that we have to take shortcuts. This has… caused the reusability of the created codes and already created components…. Very low reusability. The benefit from the development point of view would be that you have developed one of those business services once and you're quite good at it and you can do it again in less time.
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.

   Regarding the organizational factors, I don't really know. We have a problem with the business process within this company. We have a culture that says that technology is never allowed to …..That has caused some failures. We in the late 90s were looking into SAP and we realized that it would not be possible for our company to look into SAP without changing any business processes. That was not allowed, therefore we had to create everything ourselves and that did not…..

   Regarding the technical factors, there has been a problem that there had been no mature technology and when you are a big company and you have only 2 years time to deliver something, in the mean time the market has caught up and it has delivered something, now you suddenly have to choose, ok I have spent hundred billions on this and thousands of thousands of hours…should I now throw it away and then buy this thing that is on the market, that's a tricky thing, because that product on the market is never exactly what you want. So I would say we have ….this …architecture today and that we could have bought a package of product that is on the market from a vendor that has more than what we did.
3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system *3, the direct need to be able to do something*
   b. Strategy of migration *1, the most important of all*
   c. Governance of SOA

d. Business process of the company *2, it had an impact*
e. Budget of conducting migration *4.*

Factor d has really affected us. That is the unwillingness to change the business processes. Regarding factor a, it is always the …of what the legacy system is used within that gives input to the legacy system. Does this have the potential to be switched to another one, I would say. Potential of the legacy systems is absolutely very important for example we have had ..Oracle forms for which we have done a massive work to upgrade to new…technology which might not be SOA but at least the latest SOA, then it was the maintainability of the old code. Historically the strategy of migration has been a big factor. We have had very centralized systems within the company in the 80s and the 90s, there was a lot of ..solutions built out there, like in north America, they build their own systems with this and that, that is the same thing in Asia and in Germany and so on. So it was a strategic decision that we went for this centralized environment, service-oriented architecture using this and using this architecture in different layers which means that everything should be migrated into this …. It was a strategic decision and that really ..

Regarding the budget, the SOA adoption project cost a lot of hardware……before you get anything when creating this architecture. In some cases even we decided to put the legacy aside since it was even costlier to manipulate the legacy than replacing it with new code.

We had a clear direction that we need to expand the company and its maintenance…..which could be put as part of strategy.

4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?

   SOA adoption is not a project, it has been direction and approach which the company has adopted and it has been going on and on for years. I was there when they were implementing the first version of the portal in the first phase of the blue prints, there was this service –oriented architecture and these business service and so on and those services were old logic and then data was in its own presentation layer and the presentation was all down in thick client like we are on a business ..centrally …that's in the terminal server environment so the portal was the web integrated… when we developed the presentation portal …so I've been quite heavily involved. Longer to return than you go forward.

   There were many signs of early failure but when you are in the middle of the way, it is sometimes so we just had to continue. It wasn't a stage of what had been delivered, and maybe if you look at how much money have you spent. But we have been able to deliver the functionality needed, we have a stable environment which is stabilized and controlled, we have been able to support our growing company, but in the sense that…how many business services do we have that …there should only be one, but that's not the case. There are several. Because the project had not been able to take anything but their own scope into mind, we had different users with different needs, it's also ..like object oriented programming, you could create an object –oriented language that was only object-oriented. But then …really hard. If you go to the other languages, it's not strictly object-oriented but it takes … of the object world. That's when you normalize a database, the output can be completely not understandable if you normalize it to the very end. So there's a balance where you could be…otherwise it would be so complex. If you make them completely reusable, they will get more and more complex and therefore they will be very hard to maintain. Maybe it's better to create three. Implementing SOA in the real world might be as easy as it sounds.

5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)

   One problem was that application development and infrastructure development was not done in parallel, infrastructure development was done first and then application development was done to use it and then if the infrastructure is not good enough and it does not fit the purpose,

   Application development has also been hard also through the fact that.. having those layers ..at this company we have worked with Oracle for a very very long time and we have worked successfully ..logic database but that was how we did it, and in this architecture, we had to have this database…data, only data, all the logic should be in the service layer. That's a big shift in mind for application developers and we have a lot of people that have been around for 30 years and hey have their own kingdom and they act like: I am doing as I have always done. So that was a real challenge, today … it always depends on what is best for your application , you should strive to set it up this way, but when you do your..concept and when you do your system architecture, then you might find out that maybe it's not really efficient for the code to do it this way and then you have the possibility to choose the most efficient one.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?

   We have not been as successful as we expected in terms of reusability.

7. How do you measure the feasibility of converting a set of components in legacy system to SOA?

I don't know! Since I have only been involved in the infrastructure development. But if you want to transform your legacy systems into the new architecture, you always want to transform it totally and you don't want to transform only 50 percent of it.

8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
   In our company, we are talking about quite a lot of the legacy systems. Consider the state in which all the legacy systems have their logic in the database and then suddenly you want to transform all of them to a different thinking or dividing them into services that should be reusable and so on, it was the developer's mind and the development of the legacy systems. At first the development and architecture were together and then the decision was to separate them which most of the time increases the difficulty. If you stat from scratch, it is quite easy to have them separated than when you have something already and you need to transform.
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
   We had developed everything ourselves, but this issue had some effects for example our we dealt with Oracle license from having one set up ….
   For example when we were first creating out internet site, and we paid Oracle a license fee for users and users have always been the compay's …but suddenly we created an ….which had …should we pay ..the users of our internet? According to our ..model, that's obviously not a good model.
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    Absolutely. The non-functional requirements are very very important. And that has really been considered well, creating this centralized infrastructure, that one of the main issues when you have a centralized environment…also a part of this original blue print, I should work with creating a group of business service and we have a centralized…solution and a role is about connecting to having access to a business solution and so on …and also who is allowed to improve the ..we have only been …ing internal security, we are not facing external facts at all.
11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    Most often I would say it is the alternative cost and risk. When you have this legacy system, it's not always important what it costs to shift it, but what it will cost you if you don't shift. You have this store system, is it interesting if it costs hundred of millions because you have to put all the costs ext to each other.
    It has cost several hundred millions and it has taken a lot longer time (than expected) and it's been a lot harder and a lot of people have got ill on the way.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity 3
    b. Level of documentation 5
    c. Scale of changes required 1
    d. Support software required 2
    e. Reusability factors *very important in the business case*
    f. Service Abstraction *very important in the business case*
    g. Service discoverability *very important in the business case*
    h. Code Quality 4

    Code quality, if you have poor code quality in the legacy system then you will have many problems when it comes to migrating the legacy into SOA.
    In the business cases, they need something and in the end it turns out something else. Scale of changes is quite very important.
    If you look at all the legacy systems that we had, there was no question if any one of them could be left out. All of those systems had to be put in the SOA architecture so the question was which one to be put first and the top 5 factors were used to prioritize the systems. But items e,f,g were more like the benefits that you'll get when you have SOA.
    In terms of the reusability factor, it might have been better to transform the human resources systems first because that's where you have all these coworkers that are used in all other systems so if you have done that, then you can move on to the other systems. But we did not consider that. Then we have a lot of services that can be reused by other services. Reuse is reuse of code in my world.

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)

Lots of factors. Well, we don't have an SLA for SOA infrastructure but then we have an OLA. SLA is the agreement between IT and the business, we …deliver a bit of a function to you while OLA is a …. Contract where some ..of the system manager and …an agreement where the service is responsible. We deliver the service to the ..to have the SLA. We have a lot of SLAs. It is quite easy to write an SLA but the problem that we always had is how to measure.

There is of course some section about functionality and…about non-functional requirements like volumes and expected growth and the users' peak hours response times,..as we are globally spread it's interesting to …a global system or some markets and we also state …the support team, their opening hours and backup hours of certain thing..quite a lot of integration parts and those obviously have to be out of here, …

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?

I would say our main strategy in the company has been to re-develop. Our architecture has changed significantly compared to the past but I guess if you have been working with a system for seven years and then you are now to rebuild it, of course you are reusing maybe not the syntax but ..maybe the structure of it as well as the functionality. No matter what programming languages we have used in different systems.

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
16. How far have you considered the requirements from potential service users?

Very much, as we redeveloped, all projects were run from a business perspective. There are almost always other brothers or sisters to the services that we produced. This is due to not being able to provide the different users' requirements through one single service. We in this company are not very good at keeping a total view. That obviously is a problem. If you have a service right now and you want to change that, you need to know who your consumers are. Otherwise you are in trouble. And I know we have tried to create those views, and we always have this spaghetti thing. We have, in the last ..years, devided our IT architecture application areas , we have business processes now we have …and supplying and within those we can ….all..of them..application areas and within those areas, you must have total control. And then you have integration .. areas. There's a mess sometimes. W have actually had problems here, for example in the internet applications, we have this internet buying process..so in the back end of that is the same business service as the one when you go and buy something in store. It's not really the same business service; they have expanded the business service into multiple ones…one for when calling from the internet .. but from maintenance perspective it is good because when you change it here, the other services are not stopped or changed but on the other hand, if you need to make general changes, then there would be 3 or 4 of those brother services in all of which the change needs to take place. But it is always like that, you cannot avoid it, because if you have one service only, the life cycle management of that single one will be much much more complicated, and when a consumer demands for a change, you will have to ask them to wait for 6 months since you will have to prepare for that first because we have our own prioritization and they'll wait and then there are some other changes which need to be done at that very time because the user has its own products which are about to be released. So each case has its own pros and cons.

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?

I can't compare to pre-project estimations but I think they spent in terms of money, hours and time, sort of 500 percent more than their initial pre-project estimations. We have several hundred people working with this and also a lot of consultants.

One thing had not been mentioned in your questionnaire. That is about tests. Tests are very interesting. Because if you have a single system and then you are the only one using it, then … but as soon as you are working with service oriented architecture, you'll have your own development environment for your own development, then you have ..the project. Then you need a test environment where you integrate with other systems and then you'll need some stage environment to …and where do you….you need to do that quite early. And with integration with other systems. So test is quite tricky. You need to be aware of all the others ..and schedules and maintaining test environments so each component is in the correct version when you … this has been very very hard to maintain.

Thank you for your time and participation in our research study!

If there is any further questions would arise, is it okay if we get back to you with the questions?

Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

7. Transcription 2 for Case Study – A Large Swedish Company

Introduction:

1. Company name: *Large Company in Sweden*
2. Working position:
   Product Responsible / Acting Infrastructure Manager
   Internet Technical Platform
   ITIL – IT Information Library which provide service management and module how to take care all services. It is collection of best services how to manage services and infrastructure management. His role is take care or responsible for running the services. And there is another role for supporting it from user perspective, like the help desk. And there is third role which is application manager which is take care the application.
3. Duration of employment at the company: *7 years*
4. Do you want your answers to be treated confidentially?
   a. Yes
   b. No
   Yes, mention only large company.
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed
   b. Failed
   c. Still in progress
   If we see the planned cost, the planned duration, and the benefits we will have, none of those have been fulfilled. In planned cost we say 200 million but in reality we spend 2 billion. In the duration, we plan to be full successful in migration in 2 years but in reality it's more than 2 years. And for the benefits, if we create the business services, they will be reusable. But almost none of the business services have been reused.
   On the other side, we are very good on working the architecture of the system with a lot of business services and the basic infrastructure, such as service catalogs, all goals and every thing set up. For replacing legacy system is yes or no. If you have legacy system and want to replace it or transform it into service oriented architecture. It always somebody told that we don't have to transform it because it will be faced out. However in fact we will have both. In the company for example, we have very old store system, which we call it legacy system. The system created in late 80's or beginning 90's. One of the first systems we created in SOA was new store system. That new system is very successful but still using the old system at the back end. So we are still relying on the old system. We are still struggling with maintaining the old system which cost expensive.
   The system is in progress all the time. We started the SOA before it is in the market. Since we are large company, we can't just create something. We need stable architecture to build up. Since it was not available on market, we created by ourselves for example the integration buses and so on.
   When it comes in internet which is his specialty, we are transforming internet platform totally into very much more Service oriented platform. Also from partner perspective outside the company are presenting here as our sources. We call IF (IT Foundation) which is the main service oriented architecture we are using. That's only for IT internal purpose.
6. When did the company adopt SOA? *In 2004-2005*
7. Can you provide a short description of the company SOA environment? *Already mentioned before*
8. Why did the company decide to deploy SOA? *Already mentioned before*
   a. What benefits did the company expect to attain?
9. What role has each of the following people played in the implementation and success of the SOA project?
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….
   Architect is extremely important and leads developers. From the beginning it was blue print and architecture idea that this is that we want to implement. Then standardization department created the basic infrastructure, basic rule how to create business service or development tools to support it. They created it and deliver it. Then development project start to work. Obviously, when you create basic infrastructure without real consumer on that, you will be failed. When it was tested in reality, it was a lot of lack functionalities. When it comes to roles, they must be a role that connected those things together. Maybe we need like iterative approach to connect them. A role that connected those is very important.
   CEO involved in strategic planning such as deciding the budget should be spent to create the business value but nothing to do with the implementation how it can be done.

If you look at IKEA and our transformation to have this centralized IT system SOA, it was enterprise architecture role. The scope of IKEA IT foundation changes everything. There is only one way to create IT product which is transforming the legacy system.

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
   In terms of reusability and cost are not successful. The end products are good from the user perspective in most cases but on the other hand, non SOA could be also user friendly. The benefit is about how to maintain the system and how to extend it. The problem is you need to have very clear information what you do and what the others do. As soon as it becomes too big, then you have dependence with some body else. You need to be aware of what all the other people or the other project was doing. And you interact with almost every body on those projects. It could be total mess if there is someone late to deliver his part or there is someone who changes the scope of the project without telling me. We can't go on with the projects which in 3 or 4 years without delivering anything. For reusability in creating component is very low reusability. What could be good in development point of view is when you create one of those business services and you need to do it again, just use it. It will be much more quickly.
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
   He doesn't really know. We have a culture that technology is never allowed to steer the business process. I would say that contribute and cause some failures. In late 90's we used SAP and we saw that it's impossible for the company to use SAP without changing the business processes. That was not allowed. Then we have to create anything by ourselves. It has been problem with major technology in the market. When you are big company and have two year time for delivering something. In the meantime there is new product offered in the market. However what is offered in the market is not exactly the company needs. If we have created base line or base SOA architecture today, we would have some boards' packet of product from vendor in higher need more than we did
3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration

   D is really affected. The project is unwillingness to change the orientation and business processes. The potential of legacy system is always seen in the context how the legacy system is use within SOA and give an input that it has potential to switch into SOA. Absolutely it is important. For example we have very old application which we have to upgrade it to the latest technology. It was maintainability find resources skill in old code.

   Historically, strategy of the migration has been big factor. We have had very centralized system within IKEA. In the 80-90, it was a lot of local solution built. The same thing was built in different region. Then there is strategy decision to go into centralized environment to use same architecture. So that everything should be migrated into this centralized system. B is no. 1. D is no. 2. It has had impact for creating or choosing this way and so on. Potential legacy system was direct need to do something with old store system. That's no. 3. Governance of SOA is not affected in his experience for migration to SOA. But it costs a lot of hardware and spends a lot of money before you get anything when creating this project.

   We have had very clear direction which we need to expand. Quite a lot within IKEA without expanding, like maintaining resources involved the system. It's part of the strategy too.
4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
   This is not really one project. This is more rather direction of programs going for years. He was there implementing the first version of the portal in the first phase of the blue print. There are logic, data and the presentation of the system. The presentations are done in the fixed plait. We are run in the business services centrally.

   There is sign of early failure but I didn't in the position to stop it. When we come into certain point, it could be longer to return than go to forward. It's not the failed in terms what should be delivered. We have been able to deliver the functionality needed. We have stable environment. It is centralized. It is controllable. We have been able to support growing the company. In those terms, it is successful. But in case how many business services which should be once, the system have more than one business services for the same case because the project has not been able to deliver each other. Different users need different outputs.

For example in OOP, you could create object oriented language that is only object oriented but it's very hard. If you go to another language like c++, it's not strictly OO but it saves the best thing.
Another example, when you normalize database, it can be completely un-understandable its output if you normalize it until very end form. It will be too complex. It's the same thing happen with the service or the component. If we use reusable component, it can be very complex component and hard to maintain. So maybe it is better to create more than one component for same object like customer. The theory of IT technology such as SOA, cloud computing, etc are really nice but the implementing of it is not easy. So you will not be 100% SOA.

5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)
   Infrastructure development and application development was not done in parallel. Infrastructure development first then application development used it. Afterwards, the IT team realizes that infrastructure is not good enough or fit with the application. Then application development was hard to create in the application layer. IKEA has worked with Oracle very long. We have worked very successfully with having a lot of logic in the database. In this architecture, we have to have in the database. Only data in the database, all logic should be in the service layer. That's big challenge for application developers. Before we called X1A. This is the blue print of first version. Even before that was finished, we approved X1B which could have a lot of logic in the database if they want it. That was real challenge. Today is not big deal. It always tends what is the best for your applications. At first, you should straight to do it this way, but when you do the proper concept and system architecture then you might find out that it is not really efficient for the code to do it this way. Today, you have the possibility to choose most efficiently.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
   I don't know because I have been more in infrastructure development. If you have legacy system which you want to transform to something else for something else, you will transform all of them exactly. You don't want to transform it only 50% of it and then keep the rest. Now, most 90% of the system has been transformed. Only rest 10% which is nobody knows anything about that.
8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
   About architecture of the legacy system, we are talking quite a lot legacy system. For example, all legacy systems had all the logic in the database. Suddenly you want to transform those into different thinking or divide them into services that could be written in the reusable way. The question is was it the architecture the most challenge thing? I would say it was developer mind.
   The most important thing is architecture set up when logic and data was together. Then suddenly, there is idea to separate them. Most of them increase difficulty. If you start from scratch, that is quite easy to have them separately. But when you have something existing, then you want to transform it, it will be more difficult.
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
   We have developed almost everything by ourselves. I have not heard that this has been any cribber in transforming into SOA. We have problem but it is more in the SOA environment.
   Yes it has an affect to the migration, for example how you do with oracle licenses. From having one set up installed on CPU but suddenly the license is for user. But it's ok when you have one legacy system that connect to one database. As soon you create a system which connect to many systems which have own database, suddenly your license will be problem.
   For example when we create our first internet site, we paid oracle license per user. And all users are always IKEA employee. Suddenly we created the internet site which over Oracle database. We paid every user from internet according how life of model eventhough it's not good model.
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    Yes absolutely, Non Functional Requirement (NFR) is very important. That has been really considered when creating centralized infrastructure. That's the main issue when you have centralized implement instead of decentralized.
    Security aspect is also part of original blue print in how it should work with creating business services and group of business services. And you have centralized LDAP solution with a lot of roles which connected to having access to the business services. And also who is allowed to input to the business process. We have only been facing internal security. We are not facing internet security at all.

11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    Mostly, the alternative cost, risk you considered. When you have legacy system, it's not always interesting when the cost is shifted. But what if cost will be not shifted. We have the store system, it's interesting when it costs 100 million. You have to put the cost against each other.
    It has cost several hundred million more than the target. It has took longer time and a lot harder and a lot of people get ill a long the way. It's really bad and we can considered it fail as the company.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required
    e. Reusability factors
    f. Service Abstraction
    g. Service discoverability
    h. Code Quality
    In the business level it said something and in the technique level, it said something else. Scale of changes required is the most important. Support software required is no. 2. Size and complexity is no. 3, code quality is no. 4. Level of documentation is no. 5. Reusability factors, service abstraction, service discoverability are very important in the business case.
    If we look at all legacy systems that we had, it was never questions. It was not very much question that the system should remain. All systems should be put in new architecture. Those 1-5 was the one that prioritizing the system. E, f, and g are more like what we get when we get to SOA.
    I think I understand what you mean. For example reusability, it might be invented to transform the human resource system first, then you have all co workers. If you have fixed that object first, you could move on to the other staff. But no, it's not considered in our case. If we fixed this first, then the other system can reuse that.
    We have a lot of services which are used by other services but it's not reusability. Reuse is using same codes, in my words.

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    A lot of factors. We don't have SLA for the SOA infrastructure. We have OLA. SLA is the agreement between the IT and the business. We are delivering this function to you. OLA is underpinning contract where for example system manager team for certain HW create agreement to the services post book as we delivered the service under this HW to you in order to have SLA. We have a lot of SLA and those can always be enhanced. Quite easy to write SLA and to create certain point. The problem is how to measure.
    What factors do you mean?? It can be about issue or items. There is about functionality and most are about NFR like volume, expected goal and how many users, how many concurrent users, our response time. As we are global spread, it's very interesting in global system in some markets. We also stated all the involved support teams that opening hours and back up hours in certain things. We have a lot of systems which have a lot of integration parts on those we have to be notice here. SLA tends to be quite long.

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?
    We have done all kinds of interesting aspect. I don't know exactly. I would say the main strategy in IKEA was redeveloped. The architecture has changed significant. If you have been working with the system for 7 years, and you have to rebuild it, of course you will use maybe not the syntax but the structure of the system, part of the functionality or use the flow of the code eventhough it can be use different languages.

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
16. How far have you considered the requirements from potential service users?
    Very much as we redeveloped. All projects were acted from the business perspective.
    The orders are not interesting on those kinds of things in reality. It always adds another brother/sister of the services for the quite similar purpose.
    We are not very good at keeping the total view. If you have it and want to change it, you have to know how the consumers are. Otherwise you are in trouble. From time to time, we try to create those views and we always come up with some spaghetti things. During recent year, we have divided the landscape or the IT architecture to application area. We have business processes like selling, supplying, etc. Within those area,

at least you have to have total control for that area then you have integration between areas. We have some problems with those for example internet file. We have integrated the internet buying process at the back end using the same business services as you buy something in the store. But it's not really the same business services. They have expanded the business services. Here is the business service if you call from internet and here is the business service if you call from that. From making perspective, it's good because when you do changes it's only affected on that, you know who the customers are and SOA. But on the other hand, if you have to pick survive, most likely it involved 3 or 4 of those. It was very complex because we have so many customers.

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?
    I can't compare to pre project estimations, but I would say that cost and time are 500% more than the initial target. I don't want to put any cost. We have several hundreds people for several years and we have a lot of consultants working on this project.

I have one thing, you didn't mention in the question, which is about test. Testing is interesting because if you have single system and you are the one using it, you can do development while you test it and going to production. You have those three alignments.

But as soon as you are working with SOA, you have development environment when you develop it. And you need testing environment when you want to integrate with other system. And then you need some stages environment on that production.

Where do you verify functional requirement?? You need to do it quite early and integration with others. The test is quite tricky. You need to be aware of all the others then we need schedule maintaining test environment. So each component is in the correct direction when you use it. This has been very costly how to maintain and so on.

Thank you for your time and participation in our research study!

If there is any further questions would arise, is it okay if we get back to you with the questions?

Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

8. Written Answer for Case Study – Sandvik

Introduction:

1. Company name: *Sandvik Material Technology*
2. Working position: *Manager Enterprise Architecture/Chief Architect*
3. Duration of employment at the company:
   Sandvik 29 Year
   SMT 1Year
4. Do you want your answers to be treated confidentially?
   a. Yes
   b. No
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed
   b. Failed
   c. Still in progress, *techcically succeded, due to lack if information architectue/standardization the global roll-out is drawn-out*
6. When did the company adopt SOA? *At Sandvik we starded 1988*
7. Can you provide a short description of the company SOA environment?
   Since Sandvik do have almost all existing environments, this mainly due to M&A and an early adoption of IT with local presence. The start was on Mainframe z-series and i-series, today it's own developed together with products available on the market.
   We have an integration package that consists of smaller plug-ins available to be used anywhere in our infrastructure, they can act locally but we can always monitor the result centrally. This beeing able to be proactive and easier use it for trace&track.
8. Why did the company decide to deploy SOA? *Re-use and reduce redundancy*
   a. What benefits did the company expect to attain? *Cheaper development and maintenance and higher agility*
9. What role has each of the following people played in the implementation and success of the SOA project?
   a. CEO *non*
   b. Project manager *posibility to use Project Start Architecures*
   c. Programmer *follow standards and guidelines and create services where they don't exist and where it's required.*

d. System Architect *following P&G and reviewing initiatives*
e. Other party, which are …. *Infrastructure, they do want less complexity and it'll make their life easier, when integration is monitored similar over all application landscape.*

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
   The agility part is critical, this since integration is more of an configuration, but this required standardize information architecture, with information ownership, stewardship responsible for establishing business facades and methods upon the information objects. The business facades is re-usable, but since we have different legacy systems not following the standardized infromation architecture, the SOA work will be harder to implement. But a standardized infromation architecture is a pre-req for SOA and has nothing with IT-development to do.
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
   Technical skilled personnel, this since the standardization is driven from IT, but the success will not be there until the infomraiton architecture is handled in a structured way from the business. The SOA approac seldom have its problem on the technical level, the failure is mostly due to low maturity upon the infromation architecture. Global roll-out of SOA and a posibility to consume the same services globallyy, requires a global view of the information object.
3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration

   To be able to succeed 70% of the work is on the business side, this to structure the information according the the requirements from processes and capabilities.D is most important to succeed in the long term, this together with the information architecture, that is probalby more important then Processes.!? Then it's C: governance over infromation ans services. The potentiallity of item A is a lot easier when someone established the global infromation models, and the required services upon the infromation objects. The strategy from the business, what's global, harmonized or local and what information that is common or shared or building up KPI's on a higher level is of high importance.
4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
   When we had the business facades implemented outside any legacy system, we were able to deliver services from cell phone within less than a week. There needs to be reference architecure in place P&G and standards for the projects to be followed. Then the review is a smaller task. The problem historically is that the integration have been forced to structure the infromation architecture for the objects and services, this is somethin that has'nt anything with integration to do. It's as I mentioned a pre-req for SOA. Long implementations is something that the business often is nagging on, even though it's not a tehnical problem.
5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)
   It was problematic to get an understanding for establishing a stack of components (plug-ins) not relying upon any specific technology, able to be executed where ever and monitored centrally for proactice and monitoring resons. The maturity and understanding for whats important and required for a success over the life cycle.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
   It's a combination, initially its difficult for the mainframes to handle XML-parsing according to future requirements. Since we have most of the business logic residen in older legacy systems, we had to use the logic as far as possible, therefor we adde the mediation between the legacy and the business facades.
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
   The problems is as you might understand a problem concerning nomenclature and terminology and of course the ablity to handle XML in older environments

8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
   The older architecture was founded based upon consumption of information in their systems and not scaled according to current requirements.
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
   The older systems is more stable than the newer ones, the majority for the licencies is not a problem, it a problem concerning agility and this due to architecture founden back in the 70:th.
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    SOA will increase the complexity and services required other governace and co-ordination than before. The security aspect is important, this since the services is consumed by external stakeholders. Performace will often be less effective than intenal consumption and system designe consumption of thei own information.
11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    The requirement was to open up the business logic from some of the legacy systems, risk issues was initially not a big issue, agility was of more importance.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity *2*
    b. Level of documentation *4*
    c. Scale of changes required *3*
    d. Support software required
    e. Reusability factors *2 (more of standardized information delivery)*
    f. Service Abstraction
    g. Service discoverability *5 (together with governance, what's allowed to be changed or not) connected to i*
    h. Code Quality
    i. Sorry: Infomration architecture is the most important 1

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    When integration is easy to establish SLA for each service in different solutions, one SLA shoul cover the information deliver for a legacy system, independent of if the consumtion is internally, oprative integration or delivering information to DW. Another SLA should be for the integration separately. Critical is that this is don based upon a standardized way of integration and monitoring.

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?
    This is based upon different requirements, some stems is replaced, other used in the future SOA landscape. The strategy is primarily focusing on standardizing the information architecture, with ownership, so that strategy is to point out what pre-requisites SOA will need.

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture? *from the beginning the maturity for working on processe was low on the business side, even though this is critical for a success.*
16. How far have you considered the requirements from potential service users?

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?

Thank you for your time and participation in our research study!

If there is any further questions would arise, is it okay if we get back to you with the questions?

Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

9. Transcription 1 for Case Study – Sandvik (1st Interviewee)

Introduction:

1. Company name: *Sandvik AB*
2. Working position:

3. Duration of employment at the company:
4. Do you want your answers to be treated confidentially?
   a. Yes
   b. No
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed
   b. Failed
   c. Still in progress
6. When did the company adopt SOA? 1988
7. Can you provide a short description of the company SOA environment?
   Sandvik works in 3 different business areas. I am currently working for one of them even though I know exactly how the infrastructure looks like. We have different ERP systems in different business areas. We are trying to organize it around while trying to get to a common integration pattern and enterprise service-oriented thinking and that is what we need! The most important aspect when talking about service-oriented architecture is information architecture. To get the environment up and running so that it is understood by the consumers and producers. So the environment we have, we have almost any kind of object-oriented system and we have almost all the platforms in our infrastructure as well. In the integration package that we have today, we managed to exchange and consume and create information than services anywhere in that infrastructure. So concerning the environment, we don't have any problem. The problem is that the information is not understood everywhere. That is the problem and it is due to lack of maturity and lack of work …something that is critical is that historically integration takes so long time. Integration also means to standardize, harmonize and to create services for the information objects and it has nothing to do with integration.
   In a service-oriented environment it was like you have to get the services up and running and you consume everything available anywhere..just technical ..
8. Why did the company decide to deploy SOA?
   a. What benefits did the company expect to attain?
   When we started actually that was one of the biggest systems and also one of the largest projects in Sweden as well and now it specially designs products for customers. And in that area we created a system based upon a service-oriented architecture, actually …process execution and also monitoring package …so the reason for that was to make it available and to make it ..the requirements from all the business within Sandvik. But that was in one area within Sandvik ..for all the development that was performed. The reason for this was that these should be the standard package that anybody within Sandvik could use and therefore we had to create a service-oriented architecture.
9. What role has each of the following people played in the implementation and success of the SOA project?
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….
   .. at that time we didn't have any CEOs and CIOs, there was only a person who was responsible for the project's process and progress and beside that, the project was a core .. that was developing a software that should be consumed, as mentioned earlier, ..information architecture out there was the most important one. Systems architects and lots of project managers could lead the business, and over the time of course, lately we are focusing more and more on the business side which takes the responsibility. The aspect which is important is information so information ownership today is the most critical thing for going further on the service-oriented journey. Today we are a global company with a global process and that requires something completely different than just being multi-national.

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
   That differs a lot depending on the different business initiatives and also the maturity of the people on the technical aspects where the system resides. Then one thing that can make a problem is that the maturity of the XML parsers on the mainframes, it hasn't been good enough.
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
   Information architecture is the most important factor. SOA is all about making information available that perhaps services created somewhere and consumed anywhere without knowing who's actually consuming that. It's important that we have a common understanding of the information so that everybody knows what

is a product and what is contained in the price that is delivered. The delivery price is based on certain algorithms based on the interesting elements within that equation, the structure and certain business requirements need to be addressed as well. So that is the reason on we focused on for setting the business the same.something outside the system that requires or at least tells the producer and the consumer about the content of the information. This is what you get and it's according to all these rules and this is what needs to be translated according to all these rules. And since we have many systems that have been developed over the years and in response to that journey, no one else consumes that information rather than being the mainframe..so it was an internal use or ..they call and use the same information and combination, this information is totally different in Europe and US. So that is the key thing to have a common understanding of the information. How the information objects supply and what kind of business rules need to be reliable now…it's not only the technical parts where the problems are…depending on what you would like to achieve within SOA to make information available and to consume and produce it, it's a question of hard work within the information architecture. That is the critical thing that we saw when we fostered information from another system and they need to treat the information in another way and then they had ..the contract that we required.

3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration
   f. *Information architecture*.

   At that time of mainframe systems, SOA was to create a common language for certain areas but that was internally and that was actually the reason to start the service-oriented architecture. It was due to the memory capacities of the mixture to solve things and then to at least harmonize the tasks that were performed. Form the very beginning, the structure was ..then we have more and more people into the IT site and without that strategy and without any architectural thinking, everybody would be programming without any thinking. And that was the beginning when we started talking about the service-oriented architecture.
   Item f takes almost 70 % of the time and then of course, governance will be very important. Of course you need to know all the business processes since they are huge pieces of that information. One important thing is to know the information which is within the processes. Information without processes will be difficult to find. You can't live without business process technology. But the information is more important. And of course for the migration of the legacy, you need to know all the applications. So the governance is important. So from that perspective, you will also have the potential of the legacy systems. The question is: 'can we make a transition for that platform or not?' if you can't have an XML parser then why should you go for migration so it's a balanced act if you are going to use the system or f you need to convert them to something else.
4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
   In the case of the mobile application, we had everything already running. The information architecture and the services were all there. The context was also defined so it was just a technical question. The failure is always due to lack of understanding of the information. The problem was that the systems could not deliver all the information that was mandatory. In that case, the project failed but it was not failure due to technology part. It was due to the fact that the information was not mature enough.
5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)
   Information architecture is the biggest challenge that we have. The structural part of course where we have a number of processes where they have logins and in order to change and upgrade those products, we needed to redevelop the things that they had created to be able to create our development and at that time we had old PCs and mainframes. So we could have services communicating between three different technologies. One thing that is critical is to have those adapters for the environment. Data transformation was a difficult one. The systems did not have a common view of information to fill the requirements from processes from the business. This whole change was to deliver that information to a specific required context. You should transform that information into your standardized way. So we have established an internal contract for each information object which is the contract we are using when we are communicating internally. So each application will have to convert their information into an XML schema for example, which is not easy.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
   It is just trying to use what is in the system. It was not a question from the beginning. Technology part is not a problem. The problem is always to get these services into the current systems. These systems are about reading the database, so in most of the parts we have to develop things to open up the communications where you have the external or alternative consumer.
8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
   License can be a problem to a certain way. When you start thinking about integrating, you will have to decide on which program to use and in that case you will have license issues to consider. And that can cost you a huge amount of money. Of course we would like to get rid of all the licenses.
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    It is always a question of performance. We divided things in portions but on the other hand, you will gain the agility that will make up for the performance. Of course to have the environment reliable, you need to have surveillance over information. That is a critical event. And you need to have this security implemented to know who is out there consuming it.
11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    The requirements from the beginning were to open up the business. Of course it is an issue but we did not have a problem about the costs. Cost was not a big issue. We developed services internally and we used internal tools. For the risk factor, since we started early, we had more opportunities than risks.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required
    e. Reusability factors
    f. Service Abstraction
    g. Service discoverability
    h. Code Quality
    i. Information Architecture.

    Information and its architecture is very important when it comes to defining services and methods and then to have things reusable is also important. Complexity is an issue. But all the systems that we had were not designed to be used from outside. We had issues when it came to how people had defined all those systems. It might be a large issue to have, though.

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    It has been a problem because they established the SLAs in the wrong way and the legacy systems is responsible for creating this information according to the business process and that is something that should be within that SLA. And it has nothing to do with the integration board. We had that problem in business transactions and we have another SLA when we send the information to the data warehouse. And you have another SLA when you consume the same kind of information. Another SLA is for standardizing the integration.

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?
    The focus is still on information architecture. Of course in the beginning the strategy was to provide the services and the migration board did not think about the architecture. But today we mainly focus on the information architecture to establish the services.
    When it comes to the migration side, then you will have a strategy to reduce the complexity and to minimize technical diversity within the systems.
    Processes define what should be done. Capabilities describe what should be achieved. We have many consumers and there might be many producers.

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
16. How far have you considered the requirements from potential service users?
    We always try to see if this information or service is of interest from other party, either internal or external stakeholders, before defining it as a service. And then we make it reusable.

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
    We started opening up these legacy systems due to requirements from business. From the beginning, budgeting was not an issue.
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?

Thank you for your time and participation in our research study!
If there is any further questions would arise, is it okay if we get back to you with the questions?
Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

10. Transcription 2 for Case Study – Sandvik (1st Interviewee)

Introduction:

1. Company name: *Sandvik Material Technology*
2. Working position: *Manager Enterprise Architecture/Chief Architect*
3. Duration of employment at the company:
   Sandvik 29 Year
   SMT 1Year
4. Do you want your answers to be treated confidentially?
   a. Yes
   b. No
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed
   b. Failed
   c. Still in progress
   techcically succeded, due to lack if information architectue/standardization the global roll-out is drawn-out
6. When did the company adopt SOA? *At Sandvik we starded 1988*
7. Can you provide a short description of the company SOA environment?
   About SOA environment, the SOA will be different in different business area. It consists of three business areas. I am working on one of them eventhough I know exactly the other areas. We have different ERP system in different business areas. But we try to combine in common integration package in services and thinking. When we come to SOA, the most important in SOA is the information architecture that is accepted and understood by the consumer and producer. The environment that we have, we have almost any kind of ERP systems that we can account. We have almost all the platforms in our infrastructure as well. The integration package that we have today, we manage to exchange and consume and create information then services anywhere in that infrastructure. So concerning the environment without having information architecture, the problem is the information is not understood everywhere. That is the problem because lack of materiality and lack of work in business site. Historically, integration take so long time but that is due to the integration also need standardize, normalize services for the information object. And it has nothing to do with integration. In Service Oriented, the service should be running and available anywhere but technically it is most problems.
8. Why did the company decide to deploy SOA?
   a. What benefits did the company expect to attain?
   When we started to use SOA, we created the biggest system that store logic, object, data, information to provide the customer, tailor, the products in order to be able to deliver, specially to find product to customer. In that area, we created a system based on SOA. Actually we did the process, substitution, security, and monitoring package on that. The reason is to make it the way to fill requirement in the business site in Sandvik. But that was only valid in one area. That was not valid in other areas with all developments can be used. That's the reason we need to create SOA.
9. What role has each of the following people played in the implementation and success of the SOA project?
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….

The one that involved in the very beginning, first of all are the people or stakeholders in the business site. That time we didn't have any CEO, CIO, etc. That was only people that responsible in the introduction process that support the system. That was developing software to be consumed. Architecture of the system is the most important part. System architect and the project manager are most involved in the business site. That time we are weightily focusing more and more in the business site that take more responsibility. We also considered the importance of the information so information ownership is the most critical today for going further in the SOA. SOA itself is not clear. We have system, services, information that needs to be consumed, produced and developed by the company. All companies are going to be multinational company with global process. Now, we are global company with the global process that required something completely different than being multinational.

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
   That's depending on different initiatives, the people within working area, the security, infrastructure and other technical aspects where the system refined. One thing that is problem is on the XML parser on the mainframe, it has been good enough. That is one area.
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
   Information architecture is the most important factors. SOA is taking information available that we have services placed in somewhere and consumed anywhere without knowing who consuming that service. It is important that we have common understanding information that everybody know, for instance what is the product and its contain and how to deliver it based on certain author in business element within that equation. Certain business requirement need to be addressed as well. That is one of the things that we focus on setting the business. Something outside the system that required it, at least tell to the producer and consumer about the content of the information. This is what you get according to the rules and this is what need to be fulfilled according to the rules. We have many systems which developed over the years. We supported the systems and increase the information to be consumed. It wasn't the internal. That is the key things to understand the common information. The information objects are looks like what kind of business rule that need available.
   SOA is of course technical question but it is not that technical part of the department. It depends on what you want to achieve to make information available, and to consume and to produce it. It is the question in the information architecture.
   The critical thing is, when you faced the information problem, another system will adapt the information than they created before, eventhought it is fixed in the contract that they require.
3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration

   To migrate legacy system to SOA, if we go back to the early 90's. The mainframe system created services and create common library for certain areas. They called it the subroutine. They started it SOA. The reason why they started on that area is due to the memory capacity that is to organize or to perform in many places. In the very beginning, the structure is very good then we have more and more IT people in IT site without any strategy and architecture thinking. It is like the programming without any thinking. That why the important is the technical skilled of the person.
   Your questions are to look for and prioritize when we migrating the system. That is the other dimensions. From that point of view, we need to have governance to be able to fulfill the requirements and to make the process in proper way. One of the item which is quite important is business process of the company. Of course, we need to know the process within company, the stakeholders that are involved in the company and use or interest on the information. One thing that important is to know the information flow within the processes. Those processes without information are nothing. Information in processes are difficult to find the stakeholder eventhough I tried to tell the organizations, we can live without every approach about the architecture. We can live without business process and technology. The information is the most important. Among the items you gave, I try to point at the information. Within the business processes, there is information. And of course to migrate from the legacy system to SOA, you need to have some kind of overall view for all your applications. SOA governance is the prerequisite of SOA. It's important. Potential of legacy system is of course it's important but that will be question whether we can make transitition to the

platform or not. Because how to use the potential legacy system in migration. Will we use the system or convert them to something else?

4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
   That was the business to face and another thing to do about the technology. The business side should face anything about the information. The information architecture was there. The services were there. The context was defined. It was the other technical questions. The technique is not big problem. The theory is always due to lack of understanding of the information. In development, it takes so long time to set the schema or the services. But the integration code is not big deal.
   When we will failed, it is time factoring. For instance, when we deliver that, we will get the same information from another system. But the problem is not around the technology. It was that system could not deliver all the systems that was mandatory, for instance. In that case, it failed. But it was not failing due to technology perspective but it was failing due to information on that system.
5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)
   The challenges of the migrating, the less important is actually about architecture of information that is the biggest challenge we had. The infrastructure is of course we have number of products that we used. We have plug-ins implemented or adapted in within this. So if there are changing, upgrading their products. We needed to redevelop the things that we created to be able to make our development. So what we did at that time, we used those plug-ins and done it with new service. There were consumed from SAP, mainframe, etc. So we could have services communicating between this technology communicating with SAP, etc in their languages, their ways to deliver the information into database. So what we did is creating number of plug-ins that available for people to grow up and grow in for certain our formulate. And of course creating exit for certain technology. So one thing that is critical is to have adapters for business environment. It's important and why it's time consuming over years, especially if we have additional new environment. If we have one year free system, it's no problem.
   For data transformation, they have common use the information to get services that fulfill the requirement from the processes and from the business. Data transformation is critical of course. That is one of the reasons to establish the business society. You need the information. You need to deliver it according to business in the contract eventought that the information is not store in that way. That make at least much easier. Transformation of data is the most critical thing. And one thing that we are looking, we have been supposed in transform that make the system better. You should try to transform that information in system according the standardized way what we looking for. But it's quite time consuming. Try to make the data to be required in one side and others. But what we have done is we have established the internal contract to each information object. That is the contract that we are using when we are communicating. And then we try to convert to that contract. Then we are only have one format that we can use it when integrating the system. So we can say to everybody that they can provide the information according to this contract. We take care all the information to all external consumers. That's problem when we look back historically. Each individual system should convert the information according to the transaction or functionality. We had one schema internally and from that one, we convert only once to one ideal schema or one external schema contract according to audiences. That's show the possibility to integrate the external consumer or providers.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
   Yes, it is possible. From the very beginning, most of the business objects are located in the legacy system that was a mainframe. They have all the business objects and all the important information to open up our business to customers as the potential of the legacy system. Therefore we need to open up the number of services.
   From the very beginning, we have to reuse the legacy system because the customer wanted to connect our business in the new way. Therefore we need to use the legacy system and use the services from the system to provide customer the information in our system. That was not possible if we create new system then waiting for that new system. It is make customer possible to order the process especially in our system.
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
   In the very beginning, we have actually measured that we try to reuse what was in the system even tough it was called on certain point which difficult to get XML parsing implementation. In that case, we need to do something else that still created the traditionally transactional file. Of course, the feasibility is more way that for long time, do we need to transform those systems to something else or do we need to switch them sent by package. So the feasibility question what was not actually question from the very beginning. Do it

and open up the system. As I said earlier, concerning the technology part, it's not the problem. The problem is always adapting how to get the services into the current system. On those system, it reading the database, sending the information of the screen in mainframe. Most of the time, we have to develop phase to open up the information to communicate with the current program as well. And we have the external consumer or alternative consumer that the information coming from outside or from the mainframe screen. The feasibility was an issue in the very beginning. And of course looking to the other thing that our environment suit or not. It will be used to fulfill the requirement in SOA.

8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
   What we do in the architecture of the legacy system was not according to the new functional information. That is also recently, the architecture is actually based on the proper perform. You took that after and you perform reaction concerning what they enter and to update the database. That was not the layer the architecture. In some application, it was not. It always in consideration how to create services by reusing the current object and we add new logic. Before that, of course that's the consideration we need to think about.
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
   Yes, license is not problem. It's in certain way. That's not due to the legacy system I think. It's more due to the future that is if you start to think about integration, we are going to use this vendor, ex: SAP, in our infrastructure. In that case, you have license issue that you need to consider it. For instance, what you like to have is require that implemented in number of blocks. That will cost us huge of amount.
   This issue is more concerning the future. Concerning the legacy system, it's more concerning the SOA part and how to communicate and how to transport the information.
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    Of course we consider the performance. The performance will someway divided into more sub, it will have an issue concerning performance. But on the other hand, it will gain agility on that will make up the effect of the performance. And of course, to have the environment reliable, you need to have surveillance over the whole of the information that is critical. And then of course the security process is something that we given that the problem with that informally eventough that we face more in consuming the information. That is for SOA reliability issue, when you implement your system, you need to know who is out there consuming and security implemented.
    Of course we didn't consider all the aspects but in the beginning more like make everything available so that the customers do the business and our sales personnel doing the business.
11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    As I mentioned earlier, the requirement from the beginning is open up the business and information from our legacy system. Of course, it's an issue. But it's not the question about cost. We have a lot by ourselves. So cost was not big issue when we develop services and internal reuse it. We also create it within Sandvik. And we created pre-doc solution eventough it wasn't there. Yes, we need to think about the cost, but it was not an issue.
    Then the risk affecting is not an issue. It was more opportunity than risk.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required
    e. Reusability factors
    f. Service Abstraction
    g. Service discoverability
    h. Code Quality

    Eventhough you don't have this item, the most critical thing during the migration is information architecture because the information is big issues that become defining services and the information object. And then you would have the information architecture of course you have the other thing to think about reusable.
    Of course complexity is an issue. All the systems that we have wasn't defined for consumption from outside. It is the reuse issue that was for sure eventhough it always come down to reuse the information architecture how they handle it and how they present it. But we have issue of course when it comes how all people define their own system. That is we always consider it is hard changing that system toward SOA conception or not.

In some way, may people hard to do eventhough it is difficult to do for just personal services. But it should be able to create or consume all services which required by all the business. It might be hard issue to have all services. It is critical. First of all we need to consider the information architecture which is also related to the complexity of the system. Eventhough you have the same kind of issue that you can have the creation of information. I would say the size and complexity is of course one thing that we consider and it is one of the top priority area definitely. If design has been really bad, then it might cost much. So it might always an issue that the users in the system over to another system that is more flexible as well. It affects to that we always considered it.

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    We have problem with it. They establish the SLA in wrong way from the beginning. Since legacy system is responsible for creating the information according to the business process. That is something that should be within in the SLA. So delivering system is nothing to do with the integration part. That was adopt that people have SLA for the same kind of information object would you operate it in business transaction. And we have a lot of SLAs when you set the information to datawarehouse. And you have SLA when you consume the same level information of the Mainframe. SLA with concerning of information is based upon the system. Then we have SLA for the integration and the formal standard of the integration is not be old to monitoring within a complete infrastructure. You need to think and you need to architect in the layer way.

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?
    The strategy when it comes to the migration part, of course in the beginning, the strategy was to provide services and not thinking that much in the architecture for kind of different services that can be such as the customer order the tools. And of course today that the strategy is bit different. What we are doing today is focusing mainly in obsessing the information architecture. Creating the services and establishing the standard schema and try to use what is available in audience. Because that is something that the outside that start using. We tried to investing all. That is come to do in the information side. When we come to migration from the different systems then of course we want to reduce the complexity. At least to minimize the technical effort within some extend. It might today at least lead that we are moving from the legacy system to new system in certain area, not all. We do take the consideration today than within from the very beginning.
    What we tried to do in reusing the component today, we are try to define the business into capability area. The process describe how things are done. Capability describing what should be achieved. In that area, we are moving into …. Concerning the information, who are the primary and secondary stakeholder, etc. How many stakeholders do we have. We should consider it from the very beginning. And we have many consumers that might be many producer. In that area, that we do for work and we do for only one consumer. And if we have only one consumer, they might some hidden defined for SOA. If it is only for one consumer. The consumer means consumer of the information. I am not talking about the customer outside. It is who is consuming the kind of information it might be not interest from someone else. It might be that your gathering information from the machine so that deliver the information into database. And it's no more that one consumer in that area without do it as a service. We do integration today without doing SOA. It doesn't bring any business value. It will not make the complexity and lower. It might more complex and consume more CPU or consume more storage.

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
16. How far have you considered the requirements from potential service users?
    I think that we recently say that stakeholder mentioned if this service/information are intern from other partner, either internal stakeholder or we have external stakeholder. We always do stakeholder analysis, who are the one the several users. In that case define the service and make it possible to reuse.

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
    If I mentioned the key is actually in pragmatic way which start doing thing and opening the legacy system due to the requirement from business and we didn't do any budgeting for the completely scope. It was preventing the service. From the beginning, the budgeting was not an issue. Of course we have larger system that need to be opened up and we need to do how with the services. Is the information organized? Or we have proper technology tools available or not? So today of course we do budgeting.
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?

Thank you for your time and participation in our research study!

If there is any further questions would arise, is it okay if we get back to you with the questions?

Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

11. Transcription 1 for Case Study – Sandvik (2nd Interviewee)

Introduction:

1. Company name: *Sandvik AB*
2. Working position: *CIO in… technology which is one of the business areas in Sandvik*
3. Duration of employment at the company: *since 2003*
4. Do you want your answers to be treated confidentially?
   a. Yes
   b. No
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed
   b. Failed
   c. Still in progress
6. When did the company adopt SOA?
   The strategy we have now was formed during 2007, though we started to think about it in 2003. we have had a lot of investigations and we have tried the possibilities, for example we have tried the possibility to go for ERP in our company. Then we found out that it was not the right way for us. It would be a huge investment which made us put the other investments aside. We have such a huge product portfolio. We have worked with medical products. We have all the different sorts of products. We came to the conclusion that around 2006 we stopped thinking about this and reconsidered database and we came up with the steps that we are following right now in 2007.
7. Can you provide a short description of the company SOA environment?
   Within computer technology, we have 6 product areas. we have the product units which are responsible for a project's portfolio, so to speak, and the product portfolio and responsible for the development of the products being appropriate. That of course we checked in our system environment over the years, we have over 200-300 different systems. About 260 and most of the products. We have a product area to consult and .. we have a long way to go before we have one standardized environment . the operational IT infrastructure is taking care of our internal companies in IT and I think they are quite professional. We have come a long way in having a constitutioned right environment so what we are working with now is a strategy to standardize more and expanding an IT that meets your needs. There are situations where we have a lot of …requirements and that's …actually for global functionality. We have been representing internationally and we have global concepts. We are becoming such a company more and more now. And this pressurizes them really to follow this development and step by step find a way towards the future here which is manageable. That's really the challenge for us right now. it is required to have a strategy as the first step. But we still have a long way to go before we are achieving these goals many many years ahead.
   For example we have four of these Pus (Product Units) and they more or less work in the same environment and we have four variants of the developed systems. So we picked them as they developed over the years, there are a lot of databases, programs,…developed during … which means that ..to maintain and you need to have too much competence than resource and it is not easy to understand it and it is very difficult to change it into something new because you will have to develop especial functionality here. But that is only one part….if you look on the US and other companies where we have another big site, they use and info system which is called EFFECTS, and in Canada too. If you go France and other places, you will find different settings. If you go to Germany, we have something called BRAINS, if you look at one of their product areas, they have used Unix set up. What we have today is a very fragmented environment. If they chose that, then they will have to manage and supply it. Products and Customers are two most important parts. We have meta data for products and master data for customers.
8. Why did the company decide to deploy SOA?
   a. What benefits did the company expect to attain?
9. What role has each of the following people played in the implementation and success of the SOA project?
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….
   Top management: CEO and CSO and the marketing director and the manufacturing director are important. You have to have commitment from all of these people. Without them, it is useless.

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
   Productivity comes to manufacturing execution systems and then the part where you control the process and what we can see now is that it has improved the information that was exchanged between the sales unit and the production unit. Which means that when the sales unit orders something and asks for a supply, and there is too much quality information that changed. You eliminate different misunderstandings between certain areas. It really helps to harmonize the cooperation. Production is another plan and issue really.
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
   From the IT side, you need to have a very good grip of the enterprise architecture. You need to have somebody in charge of that. You also need somebody who is in charge of how you come to an agreement with your suppliers. I mean, how shall we work with product catalogues and things like that. That is another thing. as a …I think that it is a part that you should go for a process-oriented organization. .. so you really develop the process competence in that group…or if you have this distribution development part..
   From the business side, what you need is to actively be more and more process-oriented and to have an understanding for process. process ownership and information ownership.
3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration

   Business process is the most important one. If you don't have that, you can't try any approach.
4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
   We tried to organize it in such a way that we have programs, I mean , most of the programs which consist of many different projects that kept together in the program . the program is something that you can change over the years ..common goals of all the projects that are run by that program, there are a lot of these in common, the technology…each and every project should have a project manager, and you should have a business sponsor and you should have a ..which is the business case, and ..with some of the programs that we have, we have maybe 7-8 projects running at the same time, so lots of activities and there is one thing, something we have established by now is a project portfolio management. Many projects have been running out there so this is a way of getting everything together from that architectural point of view. How do you manage a project is a project management model. What kind of approach should you have for a project. And we have a common model for that which goes for all the projects.
   Of course we have had both failure and success. There are 2 main reasons that you fail: one could be from the IT side that you drive things much too fast. Faster than what your organization can really handle. You are forcing something to the organization that they are not really prepared for. For that, you need to adapt your speed with your organization. The other reason is an old traditional one. You know that when business people are coming together with IT people. It takes some time for the IT people to really understand the business and it also takes time for the business people to understand what the IT people offer. There can be some misunderstandings.
5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)
   Depending on your strategy you should be as much as possible confident that you stretch your company's business in such a way that we can …not only today but also in the future, that is the most important thing. That you will have to start with the business. And say that this is how business works, this is how we would want to have it.
   You need to have a good confidential system but you don't need to have any systems replaced from one organization to the other. They can have whatever system that they like. We can use same materials..and same products..it makes sense to have a customer-coordinator contact. Then we should start there..what does it mean for the IT strategy that you choose. You should also have a look into the fact that ok..the way the business works but you need to have some limitations, standardizing ..you should also be very careful about how much money really should you spend for the total investment that the company plans for. How much does it cost to …were there some other investments that really compete with this IT investment in such a way that you can have a step by step ..of the total investment that the company's planning for. How much does it cost for..IT ..it's also a matter of time..you speed up. Then it is the SOA approach.. if you finalise that

you are doing it, then you have the commitment and you can proceed. Beside this management commitment, even the IT is trying to guide this all the time.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
9. How far has dependency of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    It think the first three potential areas are the same when having a quality SOA. Having quality in system integration is something that can cause you enormous problems. When it comes to solutions that have a very high availability and they must be very well- maintained and supervised. I mean you should have a very proactive maintenance for such an environment. We have a problem right now with one of the system integrations and when you have SOA and your system integration doesn't work properly, ..you have to have quality of service in this case.
11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    I can just give some examples from the market when it comes to costs. You have to have a 1-2 billion Swedish kronors budget over a period of 10 years, If you have a development budget of 300-400 million, whatever, if you see that how you prioritize it to be spent, it helps that you come closer to the end target, and when you do this, that is my approach other wise you will need to go to the board of directors and they will ask you for a guarantee for a pay-back and they will call it expensive and if you have a good strategy and you know what you are having, you can plan your development budget in a smart way and this budget depends of course on how the business works for the company and you need to prioritize between your investments and IT is a huge project and we are a good sample of how we did it.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required
    e. Reusability factors
    f. Service Abstraction
    g. Service discoverability
    h. Code Quality

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    We step by step have SLAs for some areas that we have defined that so we know exactly what to expect. We are also doing that for application management area. We are doing it very much in a business related relationship in our supplies.
    In these SLAs, it is very important to focus on what you really want to have to follow ..there's a connection between quality and what you measure for costs. I think that many people try to do this much too complex and also you need to have an understanding of that . you really confront yourself with that ..what is the probability that you will have unreadability here.. We are working on it. ..and it is very important how you interact between customer supplies and how you plan your budget. How you plan changes. It is important to have a customer performance control…there are always good ideas on how you can develop a system.

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?
    The strategy is to start where you have lost commitment from the business process and to create a show case in the business…

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
16. How far have you considered the requirements from potential service users?

That's a very tricky question because we have two types of users. We have those who develop the processes where we can improve and where we can change. And we have users that are working with the inner processes and we get rather contradictory messages from these. I mean in today's processes, people just look for improvements based upon the way they work today. Especially in the system, they can always point out how to handle a problem. And then we have the processes..we have to change the behaviors that we have today and you need to balance that..because you need to have commitments from both, that's an strategy that we have in place right now..you can address these requirements in the pilot stage of the project. You work on all the problems for example and you fix all the problems for 2 years and after 2 years, they just tell you that they don't want it this way anymore

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
    We of course had initial budgeting plans. I can't really tell how much the whole project really cost but of course we had a year of budgeting considering the operations, maintenance and development. You need a budget strategy as a matter of fact. The basic rule I had was to make the change that company can see that through over time.
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?
    We organized in that way that we have about 30 people in my organization and we also have this system development company within Sandvik. We have about 300 top employees. We also have 90 people in another organization which helps us. In total we have around 500. 900 people here in Sandvik which also have an impact on how much money we can spend on IT.

    We also have some consultants working here with IT at the same time and we have all the people employed directly by the business areas and we have people in other branches in the world working in IT and they have the same situation in construction. For a SOA project, you will have to engage a lot of people in the business. I think we had around 50 of these people deciding on our prototype. That's why it is important to have commitment. You know without business commitment, you won't get solutions.

Thank you for your participation and your time!

If any further questions would arise, is it okay if we get back to you with them?

Before publishing, you will of course get the opportunity to review the interview summary, and correct possible misinterpretations if any.

12. Transcription 2 for Case Study – Sandvik (2nd Interviewee)

Introduction:

1. Company name: *Sandvik*
2. Working position:
   His working position is CIO for Sandvik Materials technology, which is one of the business area in Sandvik. Sandvik consists of three business areas. One of them is the technology during the binding construction. He is responsible for Sandvik IT strategies, which is one of them is thinking and approach to SOA.
3. Duration of employment at the company:
   He has worked in Sandvik since 2003. In Sandvik Materials Technology is in 2007.
4. Do you want your answers to be treated confidentially?
   a. Yes*, I will let you know the confidential answer*
   b. No
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed, *yes succeed*
   b. Failed
   c. Still in progress

   In comparable, we are still in track in our business. We have very strict system environment. Within material technology, we have 6 product areas. Within each product areas, we have around 15 product units. This product units are responsible to the project product and development of product. We have 200-300 different systems. Most of the product units have their own systems. Even we have long way to go to define the standardize environment of the system.

   We have internal, I mean the operating infrastructure taking cared by internal Sandvik company in IT. They are pretty professional actually when we compare them with other IT team, they quite professional. We have coming long way in having competition environment. What are working now, is more in standardized the IT and what we need to come to situation where we have a lot of local requirements section for global functionality. We have been very much in international company. We have been represented internationally. We are becoming such company more and more now because on the way we have units. And That's would be the IT item we need to develop it to be manageable. That's really the challenge for us now.

So it's still long way to go. You can mentioned it in progress

6. When did the company adopt SOA?
   What we have right now is from 2007, but we started on 2003 also. We have long investigation, we have try all possibility within our company. Thus around 2006 we think about this, and we come out with the project that following right now.
7. Can you provide a short description of the company SOA environment?
   We have development system in the majority. We have four product units. Most of them are in the same environment. Because they are collision from the same. We have four areas in develop system here. This system developed over the years with the environment we are working now. It's a lot of databases and programs and develop during business area which is you have system share that be difficult to maintain because you have so much area in sharing. It's also difficult to understand and very difficult to change into something new. So we have to develop for special functionality here, which are contain in every part. That is one part compare with some other areas. For example in US, they have another big sites in info system which we call it wik-inpact?? And also in Canada, France, we have different system. They have another system also to supporting it. So that's we have today is very fragmented. We also have no common data. Of course it depends on the good data maintain and system product data. That's about the master data. Master data for product and customers are the most important. That's the common way with the master data product. The way of the information ownership of the data describing the product. There is also characteristic unique per product that will be handled in the process. We have more than 900 different types of product. This means that you have the common way to immigrating our situation. We have many ways to describe.
8. Why did the company decide to deploy SOA?
   a. What benefits did the company expect to attain?
9. What role has each of the following people played in the implementation and success of the SOA project?
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….

   Of course you have management supporting, if you don't have, you stay commited with what you are trying to do is useless. CEO, CIO, or directors should have commitment about it. If you want to do the project, we have to have commitment. This is back to the business perspective because everything here back to business and profitability. We need to look at it from the big pictures. We should have commitment why we doing this in the management team.

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
   Productivity is against a plan, we are briefing that more in the what we call the AMI concept by facturing ….system. That is approach by controlling process there. It's about how you doing things, how you define the operations using the certain product. What we can see now is we improve the information exchange between sales unit and production. Sales unit want to produce the product, the need supply from the product unit. There are much high quality in information exchange. You deliminates workers and hours. Communication can increase the productivity to avoid misunderstanding. You can decrease the time. And you will also increase profitability there. The other is measurability. You can follow what it happen in global way. That is used to organize the corporate and decrease the time. And decrease administration that you can decrease number of staff, and so on. There is another issue in production, which are planning to having the intelligent issue, always use the best practice when produce something. That you can fit the reliability between manufacturings how they do it.
   We have also high quality product that means that product unit is very good.
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
   I think from the IT site, you need to have very good enterprise architecture which there are some body in charge of that. You also need somebody that in charge in the agreement with the suppliers which is work more with catalogues or something like that. Within IT department, it's really think the process oriented organization. So you collect all the system in manufacturing, so they just see it. So you really develop process competent in that approach. You also have distribution part. That's what I think in the IT side.
   In the business side, we need to work more and more in process oriented and having understanding of process and verify step by step the process and the information on it. So we also have business focus. When

you talk about SOA, the process are extremely important. We can't come to good understanding with the fragmented system environment.

3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration

   Come back to concept to doing the business so no. 4 is the most important. If we don't have that, it will be difficult in the approach.
4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?

   What we do, we try the way that we have program. The master data is the master program that consist of different projects. There is one thing that we are try to…because the program is something that you change if it's important. There is common goal that we need to discover, such as the technology but in this program within every project. In each program within the project, it should have program manager. You should have the business process and have warranty who paying in the business case. We have maybe 7-8 projects going at the same time. We also establish the project potential dimension. This is the project potential management. We need to get it based on the enterprise architecture point of view. Project management product is also important, how you manage the project, how you do in business analytic project. It's important that we have step by step in the project. It's also important in the methodology. The technology is more to with adopted in which are this project should be.

   Of course we have both failure and success. In the IT side, what the organization can help the project. You are forcing something to the organization if they don't want it.

   In IT project, the business people coming together with IT people. It takes some times for the IT people to understand the business side. And it takes some times for the business people about the IT people are looking for. And there are pre requirements, etc. I mean some of the stages can happen. And it's huge in terms of increase the budgeting. Sometimes it can be misunderstanding between those two kinds of people. So what we did is it takes sometimes for IT people to understand about the business, the requirements and also take some times for the user to understand. We should know what kind of question from the user and why they ask such questions. Services are always in the our business all the time but still need time to develop the common understanding about it.
5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)

   The most important when you go to the new concept in IT, you should confidence that this strategy really support the company business and it's important to see whether this have future or not. That's the most important thing when you start with the business and you can say that his is how the business work. The other thing is to deliver the productivity to the other parties. You should have a good system which make sense with the customer context. How we choose the IT strategy. The way of business work is something that we need to standardize and why we need to go for it. And also we look at how much money we need that in the total investments that the company plan. How much the costs what we expect in IT side. For other investment also.

   The main success is how far the system adopt in this company and the business plan. Therefore we need the commitment from the management then you can proceed it.

   I saw there is a company which change the system over and over again time to time because there is no management commitment.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?

    All three are the same to having the quality in the integration. That's we did. That will be problem if you don't have that. They have reliability. It must be robust. It must be very well maintain. You can have very

creative management. We have some problems right now in the system integration. And we have difficulty when we have SOA architecture and the system integration.

11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    When you talk about estimate, we can see from the market. It cost billion kr. We have development budget on that. You can do this step by step, what you prepare, and so on. It can be uncontrol cost if you don't plan it carefully.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required
    d. Support software required
    e. Reusability factors
    f. Service Abstraction
    g. Service discoverability
    h. Code Quality

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    Yes we have SLA. We have step by step in the perform area. In the infrastructure area, we have define that. We know exactly what we define on that and what we expect in the application management area. We are doing this very much in the business relationship. You can create a lot of measurement in SLA what you really have to follow. There is connection between quality and what you measure. We have to understand what I can to put in the service based on the business perspective.
    So we have agreement, and it's very important when you define how you interact between customers, clients, how you take decision, how you plan the budget. And we have also cost performance control. That could happen in application level. If you don't have that, the cost will be without any control.

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?
    The strategy is starting what you think. To create things in the business. Maybe you have to think about the process also. It's also related to why the people support it.

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
16. How far have you considered the requirements from potential service users?
    In developing project, we have many type of users, which we should consider them. So we can improve and we can change. And we are also the users who working in the business processes. It's contradictory messages. How we handle the programs. Is it a good solution for the user?

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
    Yes of course the initial budgeting plan, that's the common aspect in the project. It consists of operation, maintenance and new development. We have to benefits the project. How much room we have to take.
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?
    We have around 30 people in my organization here, in my department. Within Sandvik we have around 300 the IT team. People working with IT at the same time. We have employed the people directly in the business area. In this project, we need IT people and a lot of people from the business. So we need that IT knowledge and business perspective which connection to the business process.

Thank you for your time and participation in our research study!

If there is any further questions would arise, is it okay if we get back to you with the questions?

Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

13. Transcription 1 for Case Study – Large UK Bank

Introduction:

1. Company name: *IBM, Large UK Bank*
2. Working position: *Consultant, experience with major financial organizations in UK, mainly in banking and insurance*
3. Duration of employment at the company: *since 1993, nearly 15 years,*

4. Do you want your answers to be treated confidentially?
   a. Yes , the name of the customer must be kept undisclosed.
   b. No
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed
   b. Failed
   c. Still in progress
6. When did the company adopt SOA? 2001
7. Can you provide a short description of the company SOA environment?
   The company thought about legacy system integration and migration into components. As we offered them consulting, it turned out as some sort of service-oriented architecture was best.
8. Why did the company decide to deploy SOA?
   a. What benefits did the company expect to attain?
9. What role has each of the following people played in the implementation and success of the SOA project?
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
   Organizations are strong on the top-down business analysis. We find business modeling really different from business analysis.
3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system *3 it is important to see how much the LS constrains them*
   b. Strategy of migration *1*
   c. Governance of SOA *5*
   d. Business process of the company *4*
   e. Budget of conducting migration *2 this is done in a cost efficient manner*
4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
   We have all the time been involved in two modes: we actually measured and did the transformation of the services to check if everything was transforming correctly. Early signs of failure do exist. Some projects may even be stopped for some of these reasons.
5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)
   Brown field is trying to understand the legacy early on in the project life cycle. It is necessary because these systems are usually 30-40 years old and mostly undocumented. For Customers that don't do that, the project life cycle will be really longer and complicated and torturous. You cannot learn about the challenges until you know about the constraints of the legacy systems.
   This migration has its benefits but it is very challenging and complex.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
   It usually increases it because it is usually a mess. You have to find the interfaces. Old systems usually don't have any architecture and even when it does, it may not have been documents. Also customers usually have different products and different packages from different vendors
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
   I don't think that it truly affects the migration. In both custom-built and packaged products. It will not constrain the investment.

10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    This is very important. You need to reuse your services depending on your SLA in a way which can be used 24/7. you need to keep back ups. You need to do analysis to measure the quality. We usually rank the system implementation as gold, silver or bronze as an assessment.
11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    You measure the risks depending on customer needs.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity 1
    b. Level of documentation 4
    c. Scale of changes required 6
    d. Support software required 7
    e. Reusability factors 5
    f. Service Abstraction 3
    g. Service discoverability 2
    h. Code Quality 8

    You need to learn about the size and complexity if the legacy systems in brown field and work out the potential services that you've got. In service abstraction, you will have to think about how to turn that into a modern new service.

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    Old enterprises don't have SLAs down at the application level. I think when some customers approach new services, they will need to extend those services. And then they will start to think about creating new services and then doing the migration. So they will have to go through this process and creating SLAs is not easy. But they are on their first step to implementing service governance.

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?
    You cannot move forward towards taking up a strategy without understanding your existing legacy applications and systems.

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
    In SOA, It is fundamental how you can separate service specification from implementation. But you cannot re..your business processes. You can create a brand new business process which uses your brand new services and that is fine as long as you know about your legacy systems. So the legacy systems are very important in the quick change of the business process.
16. How far have you considered the requirements from potential service users?

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
    I think the successful transformations are the ones with cost of services analysis before they begin. We do things like function point counting and all the techniques that go around that just to understand the size and complexity and what needs to be migrated. This kind of study usually tells you how big your transformation is.
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?
    Total costs which included the total services, hardware and software, external and internal consultants was 50 to 300 million dollars and it took 3 to 5 years. Even military and government programs have huge projects which will take up to 10 years.

Thank you for your time and participation in our research study!

If there is any further questions would arise, is it okay if we get back to you with the questions?

Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

14. Transcription 2 for Case Study – Large UK Bank

Introduction:

I work in IBM and run project for the large UK bank in integration legacy system into SOA. I can always talk from scratch inside the enterprise. I can't give the name of the company, but it's the bank or insurance in UK.

1. Company name: *IBM*
2. Working position: *Senior IT Architect in IBM Global Business Services for Complex Systems Integration*
3. Duration of employment at the company: *since 1993 in IBM, nearly 16 years and 2001 in SOA project, integration and stuff.*
4. Do you want your answers to be treated confidentially?
   a. Yes
   b. No
   Yes if there is confidential, I will tell you
5. Has your company succeeded conducting migration from legacy system to SOA?
   a. Succeed
   b. Failed
   c. Still in progress
   Yes, succeed
6. When did the company adopt SOA? *In 2002, the company start to establish, probably we did before that but it is not called SOA.*
7. Can you provide a short description of the company SOA environment?
   First thing we need to think is legacy system integration to new components. As we work out the solution with focus on the demand of SOA approach. Typically, a lot of service oriented is needed to expand and respect to service oriented integration where it applies the top down in the service approach. So my experience is mostly in integration approaches.
   So I think, the customer started and defined what we called it interface clock. The list of enterprise bring the system today and start to analyze the structure of the services. The reason that was thinking about the customer which about its system. They want …. To be system but they can't do that. In one side, these programs are multi faces project. Their approach of developer work is typically happened now for the one to create the new channel. That's application is the point from legacy system. Then at the end of the translation, there is not new system that point to the new defend. But the interface is still assigned. The program staff think about interface in transition of it so the interface specification is hiding in interface implementation. So at first, the project is talking about the legacy system and the second is talk about the new back end. So then the specification was actually services.
8. Why did the company decide to deploy SOA?
   The company always thinks about the commercial oriented.
   a. What benefits did the company expect to attain?
   Efficiency, transformation, efficiency in terms of quick to deliver, business services, easier to create business process.
9. What role has each of the following people played in the implementation and success of the SOA project?
   a. CEO
   b. Project manager
   c. Programmer
   d. System Architect
   e. Other party, which are ….
   System integrator who needs the business analysis skills. Top down from the business architecture to the technique architecture interface.

General Questions:

1. How successful have SOA adoption projects been in terms of migrating LS into SOA? How far has the SOA adoption project been successful in terms of its promised benefits? (In terms of reusability, agility, efficiency, productivity, etc.)
2. What organizational / technical factors contributed to migration of legacy system to SOA adoption success / caused SOA adoption failure in your company? Explain and prioritize each.
   Yes, we are talking about the most used enterprise approach. They mainly used the IBM for the control system integrator. So the organization is strong on top down business analysis and I am staff of the business. We have strong technical people in migration of legacy system which would we find service modeling based on the business analysis. Then we have the system with SOA adoption.
3. Please explain and prioritize the following factors and their roles in your experience of migrating legacy systems to SOA.
   a. Potential of legacy system
   b. Strategy of migration
   c. Governance of SOA
   d. Business process of the company
   e. Budget of conducting migration

The factors in SOA, D is first. Usually compare with the other, the business processes are important. No. 2 probably is e. It is in the cost position managing. And probably look at a as no. 3 to see how much the legacy system constraint them. And then B is no. 4 to know how to do it. So that's it to be honest. Well, another factor is not necessary in transforming the legacy system to the new system. There are many translations in project stages. So they look at the new packages or new services to sometimes happen defined business process of the services. The point is how the organization to accept the transition of the system. They would make the centre of the system and another process around that.

4. How close have you and your team been monitoring the project progress and outcome? Have there been any signs of early failure or success in your monitored progress? What were the reasons?
   All the time, we involved the monitoring mode that helps in the strategy in our faces and the customers company in order to forward the program. We used transform measure to help them. We used it in order to keep on top the measurement. It is transforming correctly.
   Early failure is exist. It happened on our systems and the project.
5. What challenges did you have to face technically when migrating to SOA architecture? (In terms of Application development, infrastructure development, data transformation, etc.)
   Do you follow Brownfield that I sent you by email?
   Brownfield is try to understand the detail field on the system rely on our sample. We need to do this because usually …. And the developers have applied company. And the system is undocumented so Brownfield is thinking about signed survey to the analysis of the application and the data in the system to try what and how to transform. So the term of challenges we said that customer don't do that because it takes longer and complicated.
   People think still use the legacy system and understanding how much transformation would happen. They are like to much more flexible.

Technology Perspective:

Factor: Potential of Legacy System

6. How far did you consider the potential of legacy system in the migration process? Did you use most of the components of legacy systems in the system using SOA?
7. How do you measure the feasibility of converting a set of components in legacy system to SOA?
   For no.6 and 7, the point we find out whether through automated technique with Brownfield or with the manual analysis without start until the constraint of the legacy system, you can't really work how to work out the services looks like in the project.
8. How far did you consider the architecture of the legacy system? Does it increase or decrease the difficulty of the migration effort?
   It usually increases difficulty. First, we have to find the interfaces and then the legacy system usually uses on it. They have the architecture and built documented and also have different packages and different technologies which play on it. So interface analysis is usually to find how the architecture is.
9. How far has dependence of legacy system on commercial products (product license, etc.) affected the migration of legacy system to SOA?
   I don't think commercial product affect the migration. It depends how far company want to meet, for example the mainframe and they want to transform the application into new system. If you don't use the right hardware to operate it and right OS then you might hard to migration and have measurement problem. So it was not that affected.
10. Do you consider the quality of service (in terms of performance, reliability, security, etc.) as a success factor when conducting the migration process?
    This is quite important. We told earlier it's cover what a service agreements could be. We need to understand if we want to reuse the legacy system to be services providing implementations, the reliability and performance are important too. The point is we defined the services by 24/7. So we need to back up. So again discovering the legacy what they offer.
    For measure it, we just do our system work out. What we usually do is rank existing programs and like assessment how much it failed. And work with new things in term of project services.
11. How far did you estimate the cost, difficulties and risk when measuring the potential of legacy system for being reused in SOA?
    There is assessment in the project in the life cycle, including the cost. To be honest, when you use different consultant, there will be different way to measure it. Then the customer will difficult to depend on it.
12. What important role did the following characteristics of the legacy systems play in the suitability of the legacy systems for being migrated into SOA? (Prioritize them from 1(most important) to 8(least important) and cross out (×) the ones you do not consider as important at all)
    a. Size and Complexity
    b. Level of documentation
    c. Scale of changes required

d. Support software required
e. Reusability factors
f. Service Abstraction
g. Service discoverability
h. Code Quality

Yes absolutely, they play roles in the migration to SOA. A is no. 1. B is no. 4. C is no. 6. D is no 7. E is no 5. F is no 3. G is no 2 and H is no. 8.

Something that I want to say here is that Brownfield that point in order to work out how to do in the migration to understand the size and complexity of the system. Then no. 2 is G to work out what potential services in the legacy system and what kind of the services to be exposed. And then service abstraction to find out how to convert it into model new services.

Factor: SOA Governance

13. What factors have you considered in your SLAs (Service-Level Agreement)? (Do you have an SLA?)
    For developing Enterprise, we really have the SLA for the application level that understood. I think when customer approach new services. Then they want for example mail services, like google mail or CRM.....com. Then their services and SLA are in pre package. When we are looking inside the organization, then we might not be central SLA in the legacy system. So when we start think about creating new services and then migration. They are always trying to go to the processes of SOA inside the organization. So that might be difficult for them because they are in the first step to implementing the services government.

Factor: Strategy of Migration

14. What migration strategy/ technique did you choose? Why?
    The point in the article in developing work that is either strategy to service extends. I think it's important but it is as no. 4 because we need to understand the existing system first. We have to be careful with what we though and interpret especially in creating the new function. I am not sure how you do migration if you are not understand your existing system.

Business perspective:

Factor: Business Process

15. How dependent was the business process of the company on the IS legacy architecture?
    Absolutely, SOA adoption need changes in business process. Fundamentally how SOA work is you can separate service specification from that implementation and it helps you for the business.

    Yes, the business process dependent on the legacy architecture. It can't just implement the code. We can break the business process which is reused and which is open new services to be defined. And then we establish the services implementation for that existing system. How modes the business processes changed quickly.
16. How far have you considered the requirements from potential service users?

Factor: Budgeting

17. How far has initial budgeting affected success in migration of legacy system to SOA?
    Again, I think successful transformation, we need software analysis before begin the project to estimate the cost also. We do things like function accounting and other things around that, just to understand size and complexity what to be migrated. That is used to know how big the transformation. They have to understand very well about the system and the well documented. Otherwise, they will be on big problem. So I think successful migration contain their work in the approach that services analysis and the logic into the program.
18. Can you provide us with some estimation of the total costs in terms of both human resources and monetary expenses the project implementation has had for the company compare to pre project estimations?
    OK, in the project the total cost which is hardware, software and services might be external consulting services or internal people. This program is usually need millions dollar and 3 to 5 years. It is the enterprises. It usually has 3 years target. I am not sure if that is special achieve information from CEO. So we have three alignments. So in 3 years, it usually build a huge program. It also need to adapt with market changes because it changes quickly.

Thank you for your time and participation in our research study!

If there is any further questions would arise, is it okay if we get back to you with the questions?

Before publishing the final essay, you will get the opportunity to review our interview summary, and correct possible misinterpretations if any.

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