The Impact of Service Oriented Architecture (SOA) on IT Auditing

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Executive Summary

This study investigates the impact that SOA has on IT Auditing. Service-oriented architecture emerged as new technology in literature since 1996 and it has been a hype in the Netherlands between 2006 and 2007. The development of new technologies is faster than the developments in IT auditing profession. IT auditors have stated in interviews that they are aware of the impact that SOA has on their profession and that SOA will need another audit approach, because the environment is different than the traditional IT environments on which audit programs are based on. Auditing SOA is a complex process, but by approaching it from the business processes and stages in the Software Development Life Cycle process, the auditor can gain more insights to audit this complex environment.

For the full text of this master thesis refer to the following webpage: http://hdl.handle.net/2105/5102.

1. Introduction

1.1 Research background, problem and questions

The first publications of service-oriented architecture came out in 1996 by Gartner. Since then a lot of companies decided to adopt this new architecture. It has been a phenomenon for already thirteen years and we still see that documentation on the supply side of this technology is more than on the demand side. There is not much literature about successful implementation of SOA and neither of the impact that SOA has on management and internal controls.

In 2008, SOA could be found in the "slope of enlightenment" in the Gartner hype. This means that SOA is now mature and a lot of knowledge and experience about SOA is available in the IT branch. In different Dutch researches the expectations of organizations, the success factors and the pitfalls of SOA implementations were published in 2007. In the Netherlands SOA was a hype between 2006 and 2007.

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There are many publications and researches done on SOA, but most of them are focused on technical aspects. Because there is a lack of literature about SOA and IT auditing, the opportunity has been taken to put the focus of this research on the impact that SOA has on IT auditing.

There are a lot of definitions for SOA, some from a technical perspective and some from a business perspective. The definition that will be used in this thesis is the one according to Marks and Bell [2006]:

> "*SOA is a conceptual business architecture where business functionality, or application logic, is made available to SOA users, or consumers, as shared, reusable services on an IT network. Services in a SOA are modules of business or application functionality with exposed interfaces, and are invoked by messages.*"

Furthermore, the SDLC Software Development Life Cycle) process has been chosen to point out the importance of an IT auditor during software development activities. The SDLC process is a process that is underestimated by organizations. They forget that this is the process they need to follow to build their systems and it is also a process that can be used to control efficiency. According to the Information Systems Audit and Control Association (ISACA) [2003] the systems development life cycle can be defined as:

> "*the process involving multiple stages (from establishing the feasibility to carrying out post implementation reviews), used to convert a management need into an application system, which is custom-developed or purchased or is a combination of both.*"

This process is being underestimated by organizations. IT audit also focuses on the SDLC process. This process became important to organizations and auditors since both groups realize that auditing a system after implementation is inefficient and this inefficiency could be decreased by auditing the SDLC process, which means auditing systems during the development process.

The scientific relevance of this research is related to the fact that research in the field of SOA focused on IT auditing and compliance has not been conducted. This research aims to identify the changes the IT auditing world will need, to be able to audit service-based IT environments. It also aims to make the IT auditing world aware of their position and their importance for organizations.

The business relevance of this research is more related to companies that have or will have a SOA environment and also to accounting firms who are delivering IT audit and compliance services to other organizations. This research aims to make the accounting firms aware of the changes SOA brings for organizations, so they can adjust their audit approach without forgetting the objective of an audit: collecting and evaluating evidence to determine whether a system safeguards assets, maintains data integrity, achieves organizational goals effectively, and consumes efficiently. It also aims to remind organizations that the SDLC process is an important process that should not be underestimated.

To be able to reach the above mentioned aims the following research question is addressed in this study:

Would SOA have an impact on IT auditing and if so how are related IT auditing aspects affected?

Sub-questions that support the main research question, also addressed in this study are:
- How does SOA differ from a traditional IT environment?
- Is the SDLC process an important process for organizations and IT audit?
- How are technology, people and processes related to IT auditing and SOA?
- What effects does new technology have on the future of IT auditing?

1.2 Outline

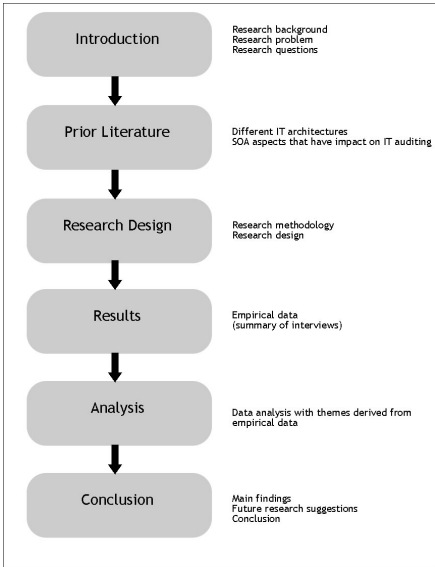This article consists of six sections, as illustrated in figure 1-1.

Figure 1-1: Outline article

The first section gives a brief explanation of the research background, objective and the questions. The second section contains the prior literature, it explains the different IT architectures, the SOA aspects that have impact on IT auditing, the SDLC process within SOA and the IT auditing profession. The third section explains the research methodology used for this study and the research design, which explains how the different parts of this study are related to each other. Section four provides the results of the research and section five the analysis of the results. The last section, section six, contains the main findings and the conclusion on the research.

2. Prior Literature

2.1 Different IT architectures

To be able to get an overview of the different IT architectures that have been existed and still exist, it was necessary to go back in time. More than forty years ago organizations establish their own IT departments using different kind of systems with their standard application functionalities and they had their own data centre. In the 70s and 80s modules in business systems became popular. These modules were supplied by software supplier or were developed in house as custom-made applications [Vessiliadis et al., 2006]. In the 90s and the following years organizations began to use third parties for the delivery of application functionalities and IT outsourcing became a hype. The reasons for outsourcing are shown in figure 2-1 [ITGI, 2005]:
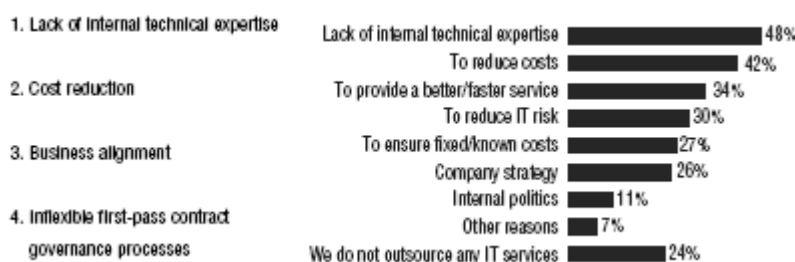

Figure 2-1: Reasons for outsourcing [ITGI, 2005]

Different outsourcing techniques are [Butler, 2008]:
- ASP (application service provision): third parties (application service providers) offer, host and manage applications remotely at a central location (data centre) on a one-to-one basis to customers;
- Saas (Software as a service): service providers develop, offer and deploy software applications that can be accessed by multiple service consumers over the internet.

The first publications of SOA were in 1996 by Gartner. In a SOA there is a collection of numerous services from different sources (internal or external or a combination of both). These services are integrated and can interact and communicate with each other. Aspects that will influence the auditor's activities in the different IT architectures are the place where applications and data are hosted, associated risks and who is responsible for the controls. These aspects are different in each of the IT architecture previously mentioned. The differences in the IT architectures are illustrated in below figure 2-2 [Butler, 2008].
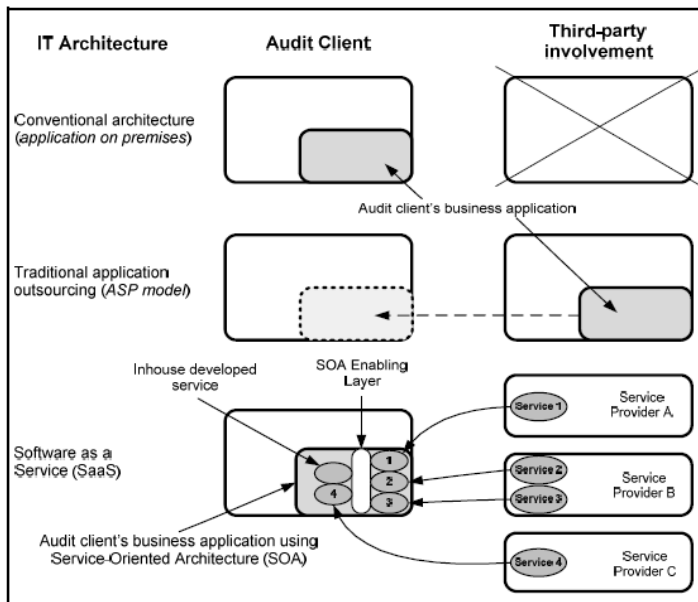
Figure 2-2: Differences in IT architectures [Butler, 2008]

In different literature ([Artus, 2006], [Marks & Bell, 2006], [Thomas, 2007]) it is explained that SOA is chosen because of its flexibility within the business processes, but still the figure above shows SOA as a complex environment.
The differences between SOA and the other IT architectures are [Butler, 2008]:

- SOA is process-oriented and heterogeneous and traditional architectures are functionality – and application driven;
- Life cycles in SOA are shorter than in traditional architectures. A lot of changes are made in a SOA environment and this supports flexibility;
- SOA is based on messaging and traditional architectures on objects.

Looking at the first difference of SOA between the traditional IT environments, the auditor will have to change his strategy in a SOA environment [Butler, 2008]. Because SOA is process-oriented, the auditor will have to focus on testing the business process from the beginning till its end. He/she will also have to audit each business process that can include different services, individually. This means that the auditor must gain an understanding of the environment and must have an overview of all services in the SOA environment.
Looking at the second difference mentioned above, it can be said that although a SOA environment creates flexibility for businesses, it creates complexity for auditors. A SOA environment is a complex audit environment, because it continuously changes.
The third difference brings along technical challenges for the IT auditor as a SOA environment is message-oriented. Knowledge of security aspects within messaging will be required.
Furthermore, Haines [2007] stated that SOA brings along changes in developer skills, roles, tools, processes, and organizational culture.

2.2   SOA aspects that have impact on IT auditing

As already described in section 2.1 there are several differences between SOA and traditional IT environments. In previous section 2.1 the impact on IT auditing is approached from the three differences mentioned. The challenges for the IT auditor will be discussed further in this section [Butler, 2008]:

1. Because SOA is a complex environment, the auditor will need technical skills. As already mentioned, difference number three, messaging, will require technical knowledge to be able to audit the security aspects within SOA. The auditor must understand the environment;
2. Flexibility is one of the key adoption factors of SOA. Where SOA creates flexibility for businesses, it creates complexity for IT auditors. SOA changes a lot, because of internal factors (scalable and manageable systems) and external factors (competitive issues and global markets). A continuously changing audit environment will affect the nature, timing and extent of the audit approach;
3. Risk assessments will still be an important activity of the IT auditor. The risks related to SOA are: security, insufficient segregation of duties, data confidentiality, integrity, and business continuity;
4. Service level agreements define services in a SOA environment. They describe the relation between the service consumers and service providers. An IT auditor is required to understand the SLAs, as they describe the services involved, and the obligations and responsibilities of the parties involved;
5. The SOA enabling layer is a very important part of the environment. This is also a challenge for the auditor, because this layer integrates the components in the SOA, controls the messaging, and access control and security elements can be defined here;
6. Besides the aspects already mentioned above, there's another aspect that is also very important and it may have impact on the activities of the auditor. A successful SOA environment also depends on the technical skills of employees and the ability to plan, coordinate and effectively manage the environment.

2.3   SDLC in SOA

The SDLC process is mostly forgotten by organizations. This process is being audited in organizations, where they have to comply with rules, regulations and legislations. This chapter aims to discuss the differences there are between the SDLC process of a SOA environment and the SDLC process of a traditional IT environment.
ISACA [2003] provides an IS guideline for reviewing/auditing the system development life cycle. In this guideline all aspects that need to be reviewed are summarized. According to literature [ISACA, 2007], this process is being audited, by reviewing documentation of each phase. Whether this is an effective and efficient way of auditing this process is not evident. The differences in SDLC activities will be outlined in table 2-1 from the traditional SDLC point of view, by looking at the ways in which the traditional life cycle activities change in an SOA environment [Lewis et al., 2008].

Traditional SDLC phases	SOA SDLC
Requirements	In an SOA environment, this requires a business process management (BPM) focus and it includes a large number of stakeholders. One of the characteristics of SOA is that it aligns the business with IT. During this phase it is important to look at the inventory of business processes and services.
Architecture and Design	Activities during this phase in an SOA environment involve: • setting up responsibilities of service consumers, service providers and the service broker. This decision must lead to loose coupling; • making decisions which technology and standards to use. Standards for a SOA based environment are still emerging; • implementing quality of service attributes; • determining the degree of service reusability to get the most benefit out of the architecture.
Testing	Testing in a SOA based system must be done from the service provider's as well as from the service consumer's perspective. From a service consumer's perspective it is very important to test on the exception handling as services could become unavailable and disappear without notifications. From a service provider's perspective the service will need to be tested on direct user's level and on the level of users of the service interfaces. Test cases must cover all business processes that use one service. Because there are SLA's between the service provider and the service consumer all tests need to consider the agreements in the SLA's.
Implementation	In an SOA environment implementation activities include checking on loose coupling and the common infrastructure components such as security, service repository management, and data transformation. As in any other distributed system development, there is no guarantee that the system will work in production (run time). This is also a problem in a SOA based system due to technology and standards that support the execution of the system.
Maintenance	Maintenance activities in an SOA environment are very complex and this can increased when external service consumers and providers also have access. Service providers have to consider a set of unknown users if tracking the service consumers in the SOA infrastructure is not possible. There are direct users of the old systems and users of the service interfaces. Besides user management the configuration management also becomes complex, because it is very difficult to decide what to put under configuration management; there are a lot components, e.g., service interfaces, configuration files, test instances etc.

Table 2-1: SDLC differences [Lewis et al., 2008]

According to Lewis et al. [2007] SOA has a major impact on SDLC because of the following characteristics: business agility, reuse of legacy systems, adaptability of applications, and interoperability of systems. He also stated that there are misconceptions about SOA that

make organizations believe that developing SOA is not different from developing traditional IT environments.

Gu and Lago [2007] has proposed a service life cycle management, see figure 2-3, that consists of three stages to build their SDLC model. The three stages are:
- design time: this is the life cycle of a service before it is being used;
- run time: this is the life cycle where services are put into production;
- change time: this is the life cycle when services need adjustments.

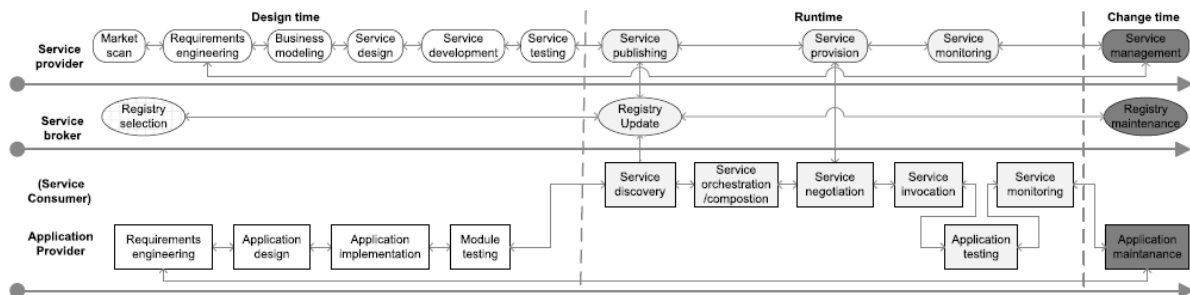Each stakeholder will be responsible for the activities within these three stages.

Figure 2-3: Life cycle activities associated with services in SOA [Gu & Lago, 2007]

2.4 IT auditing

Drivers of IT auditing
It auditing now, is not what it was years before. Years ago auditors were accountants who gave second opinions on the integrity (quality, completeness, accuracy) of a company's finances. The objective of an audit was delivering assurance to stakeholders and authorities [Hinson, 2007].
Because IT plays a significant role these days in organizations and transactions are done through IT systems, the business risks on the level of information security threats and vulnerabilities have increased. This is one of the reasons why an IT audit became part of a financial audit and why organizations began to invest little by little in IT audits.

According to ISACA [2008] and IT audit can be defined as:
> "*any audit that encompasses review and evaluation (wholly or partly) of automated information processing systems, related no-automated processes and the interfaces between them.*"

As mentioned before, the technical advances in IT is one of the reasons why the demand of IT audits increase. Another reason that can be seen as a driver for IT audit is the interest in governance, risk and compliance. After economic scandals like the WorldCom and Enron scandals governments began to set compliance regulations to which companies have to comply with. Frameworks like COSO and COBIT became popular because organizations interest in IT controls became bigger than before. The third reason is related to changes in the way organizations began to use IT. There was suddenly an IT explosion and IT became a

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department on its own in organizations. Companies became aware that they can use IT for their business and strategic changes and business-IT alignment started to increase.

Audit standards

IT auditors use techniques, methods and tools to perform their activities. In different literature [Hinson, 2007, ISACA, 2008] the techniques, methods and tools are described. Besides these there are also audit standards to which the auditor needs to comply with when performing an audit. Audit standards guide the auditor during his audit activities. The International Auditing and Assurance Standards Board (IAASB) has setup the International Standards on Auditing (ISA). These standards provide the auditors the necessary guidance to address those issues of greatest concern to the public as well as the markets [IAASB, 2007]. Over the years, countries are using and are adopting or incorporating these ISA's into theirs national auditing standards.

SWOT analysis on IT audit

Hinson [2007] has performed a SWOT analysis on the IT auditing profession. This analysis describes the positives and negatives of IT auditing and gives an overview of IT auditing in time. The past, present and future of IT auditing can be derived out of this analysis. The following figure 2-4 shows the SWOT analysis.

Strengths	Weaknesses
IT/information risk, control/security, and governance focused specialism. Provides independent, objective assessment. Provides assurance to stakeholders. Applies structured methods systematically and rigorously. Increasingly viewed as a true profession.	Audit is viewed historically as an accounting review function, a rather cynical and negative one at that—the business benefits of auditing are seldom promoted or understood except perhaps at executive board level. IT auditors who focus too deeply on the technology may miss the wider organizational context and human issues, hence neglecting important business risks.
Opportunities	**Threats**
Collaboration with non-IT auditors and other business people. Strong IT audit tools, techniques, and methods (more later). Proactive auditing (e.g., tracking software development projects from cradle to grave). Innovative change catalyst. Global cross-fertilization of best IT and business practices.	Over-commitment—IT is everywhere. Unreasonable expectations due to complexities both within the technology and in the way it is used and abused. Being put into the "compliance" box (e.g., the function is to assess compliance with SOX, not to stimulate/promote added value). Dissolution of IT audit as a discrete specialism because virtually all auditors need IT audit skills.

Figure 2-4: SWOT analysis IT auditing [Hinson, 2007]

Besides the SWOT analysis, Hinson [2007] also explained future directions for the IT auditing professions. According to him the following needs attention of IT auditing:

- New technologies will be a challenge for IT auditors as the risk landscape changes and this will make that IT audit specialism will emerge;
- Added value of IT auditors must be more than only identifying risks in IT systems. Therefore they should have business and technology skills;
- IT auditors must not only focus on the technology, but also on processes and people. They need people to give them a better understanding of the environments and therefore they will also need people skills as well;
- There must be more cooperation between different auditors.

3. Research Design

3.1 Research methodology

The research is a qualitative research. According to Myers and Avison [2002], it is a research method

> *"developed in the social sciences to enable researchers to study social and cultural phenomena".*

Qualitative research can help the researcher to understand people and the social and cultural contexts within which they live according to the authors. Qualitative research consists of different qualitative research methods and qualitative data sources. Examples of qualitative research methods are action research, case study research and ethnography. This research is based on the case study method. According to Benbasat et al. [1987],

> *"a case approach is an appropriate way to research an area in which few previous studies have been carried out".*

A multiple-case design is used, as different IT auditors will be interviewed. Furthermore, this case study research is an interpretive study since the opinions and experience of IT auditors are interpreted with help of the interviews and questionnaire.

3.2 Research design

The first step during this research was gaining more information about service-oriented architecture and IT auditing. This is done by reviewing literature. The second step was setting up interview questions. The third step was conducting the interviews and collecting the empirical data. The interviews are recorded and there is a transcript of each interview. Empirical data is analyzed by comparing the reflections and opinions of the interviewees using critical thinking. The last part of this research will be the conclusion. The opinions of the auditors will be compared with the literature review and a conclusion will be drawn.
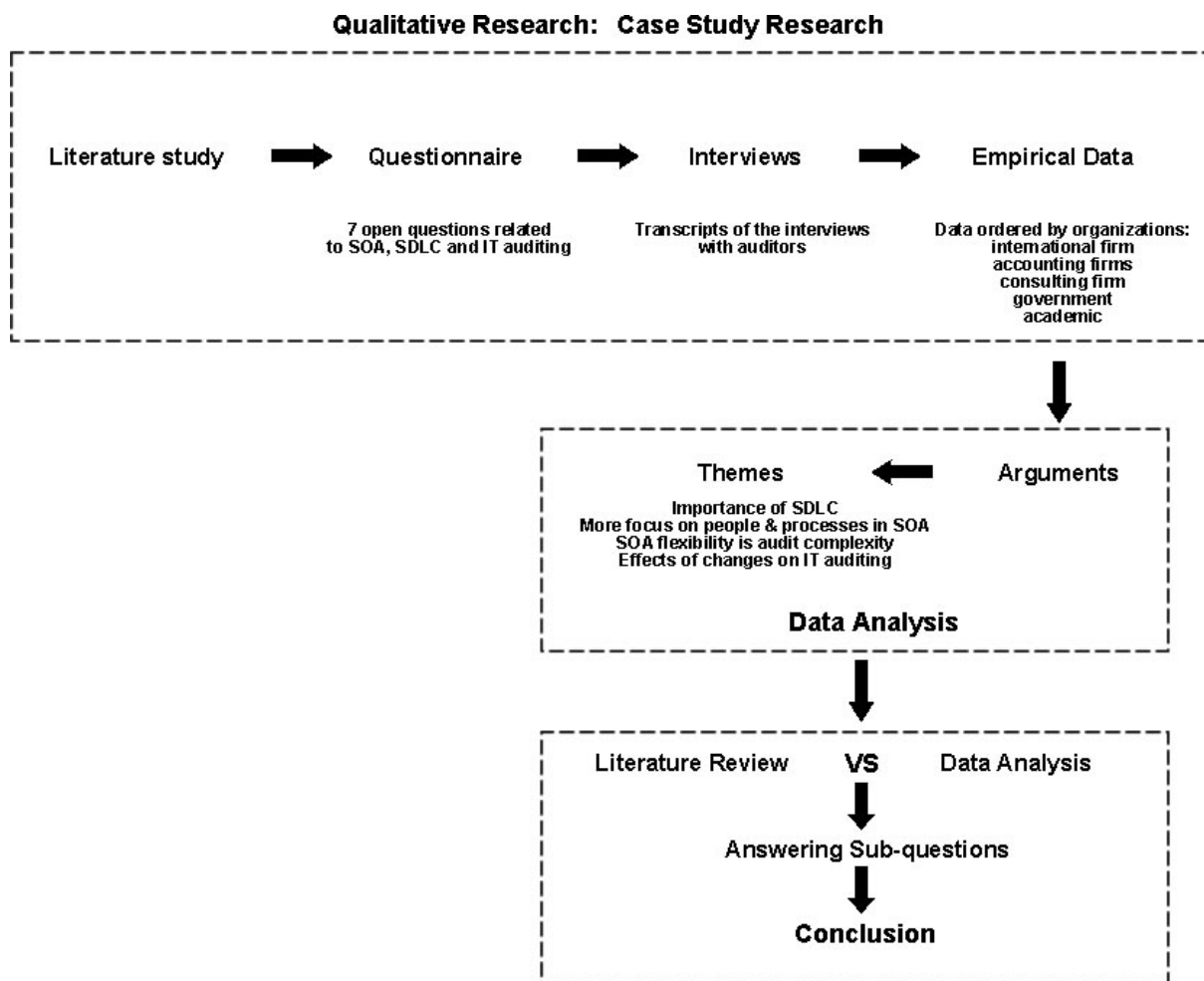This process is illustrated in figure 3-1.

Qualitative Research: Case Study Research

Figure 3-1: Qualitative research

4. Results

As explained in the research design, interviews were conducted. Ten auditors were interviewed and they are from different organizations. The interviews are ordered by these different organizations:

- two auditors of an international manufacturing firm (This firm has to comply with SOX regulations and is on it is listed on the US stock exchange);
- two auditors of a Dutch consulting firm (This firm delivers only IT audit and compliance services to other organizations and is specialized in SOX compliance. It is a SME);
- two auditors within the Dutch government (The Dutch government has its own IT audit organization);
- three auditors of different accounting firms (These firms deliver IT and Financial audit and compliance services to organizations);
- one auditor of a Dutch university (This auditor is a professor at the Dutch University and coordinates the IT Audit Post-Initial programs).

The auditors gave their opinions on 6 different topics related to SOA, SDLC and IT auditing:

- auditing SDLC
- service-oriented architecture
- audit standards
- people
- processes
- future

In the complete study[2] a detailed description of each interview can be found. Important statements and arguments are selected from the interviews and are used within the analysis of the collected data.

5. Analysis

The different point of views of the interviewees are described and evaluated in this section. The purpose of this is to find correlation and relevance to different themes. Arguments that will support this process are illustrated in figure 5-1.
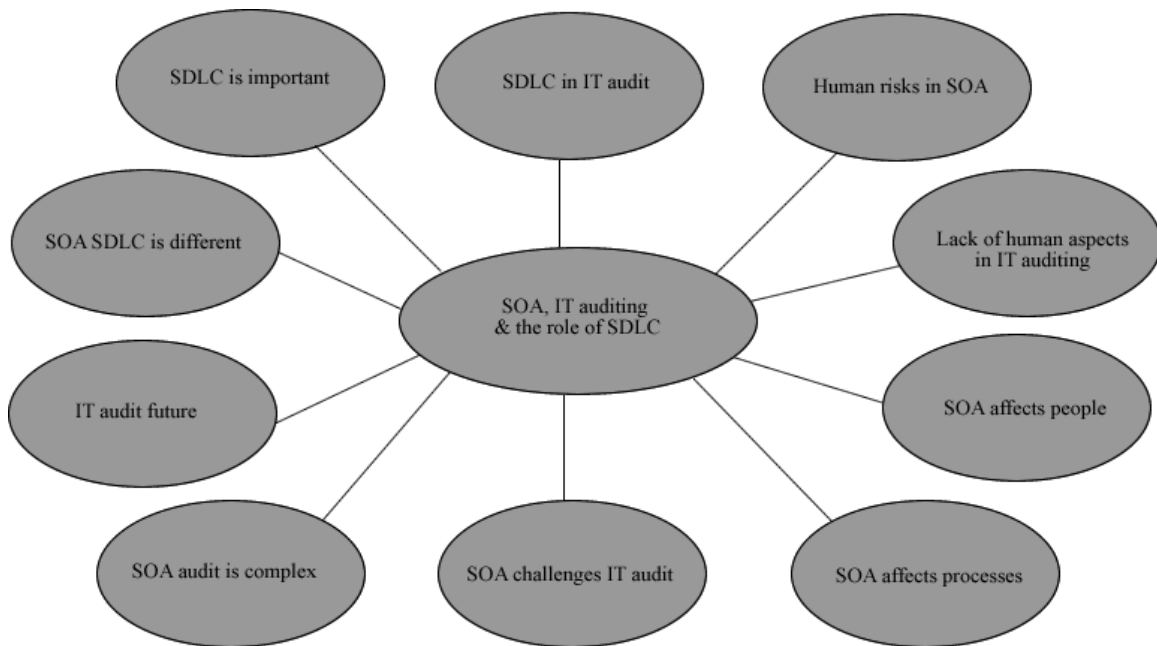

Figure 5-1: Arguments supporting the data analysis themes

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[2] The complete study can be found here: http://thesis.eur.nl/thesis/index/783769483

Importance of the SDLC process

The SDLC process is a very important process that could help organizations during their development and implementation activities. Many organizations are not aware of this and they underestimate this process. This process is a standard and organizations are using it differently. Organizations are not aware of the fact that this process can guide them through the implementation process of internal controls. Therefore it can be considered as a very important process. When implementing governance controls, application controls, data controls and management controls during the SDLC process, management of the IT environment will be much more efficient. During this process a lot of other management processes are being used for example project management. These processes guide the devolvement team and after implementation the organization can be ensured of a system that

works well. All the interviewees have stated that the SDLC process is very important and that internal controls can be implemented during this process.

As mentioned before, the SDLC process is a standard and organizations use it differently and they even create their own SDLC process. This depends on the organization and the IT environment. Service-oriented architecture is a new technology where the development of services based on business processes is one of the activities. The SDLC processes in such architecture would be different than one in a traditional IT architecture where developing applications was the core. The first difference is the end product; in a traditional IT environment the end product is an application and now in a SOA it is a service. Besides this difference, there will be more differences in the activities of each phase of the SDLC process. These differences are caused by differences in the environment and tools to be used. The interviewees have stated several differences that will occur during the performance of the activities, e.g., differences during the testing phase and requirement phase. The following table 8.1 shows some differences in activities of each phase of the SDLC approach, based on opinions of some interviewees:

SDLC Phase	
Requirements	The focus in a SOA is business process; this means that business analysis will be very important in order to identify all business processes including legacy applications.
Architecture & design	Because the architecture of a SOA is different, the technical design will be different. Design blueprints are necessary to be able to have an overview of all aspects and to be able to implement internal controls.
Testing	Testing in a SOA environment is a complex process. All stakeholders need to be involved in the testing process and human testing is complex because of the possibility of unknown users in a SOA environment. Involvement of the SLAs during the tests will be necessary.
Implementation	The interviewees did not mention any examples of differences in the implementation phase in a SOA environment. Most of them were sure that not many will change during the implementation, except that the technology is different.
Maintenance	Because life cycles are short in a SOA, disposal will take place fast. Maintenance will be a complex process, as this is different from each stakeholder's point of view. User management is a very complex process, because in a SOA there are internal and external users and there is a possibility that unknown user-access exists.

Table 5-1: Changes in SDLC activities

The SDLC process can also be reviewed during an IT audit. Many organizations make the mistake to consult an IT auditor after the implementation of a system, but the best time to consult such an auditor is during the development and implementation activities. The auditor can guide the organization through the implementation process of internal controls and can also advice on audit requirements. In this way gaps during the development can be found on time and they can act on them directly. It is more efficient to audit during the SDLC process than at the end of an implementation. This saves time and costs in system development. Most of the interviewees have stated that it is important to audit during this process, because it can be used as a verification tool. The interviewees have also given their opinion on how they would review the SDLC process.

5.2 More focus on people and processes in a SOA environment

A service-oriented architecture is a new technology that is not any longer a hype. Still organizations underestimate the implementation of such architecture. People, processes and technology are three aspects that have effects on each other when one changes. In this case we can see that SOA is a new technology and it affects people and processes.

Figure 5-2 illustrates a better understanding of how technology, people and processes are related, when new technology is being implemented:
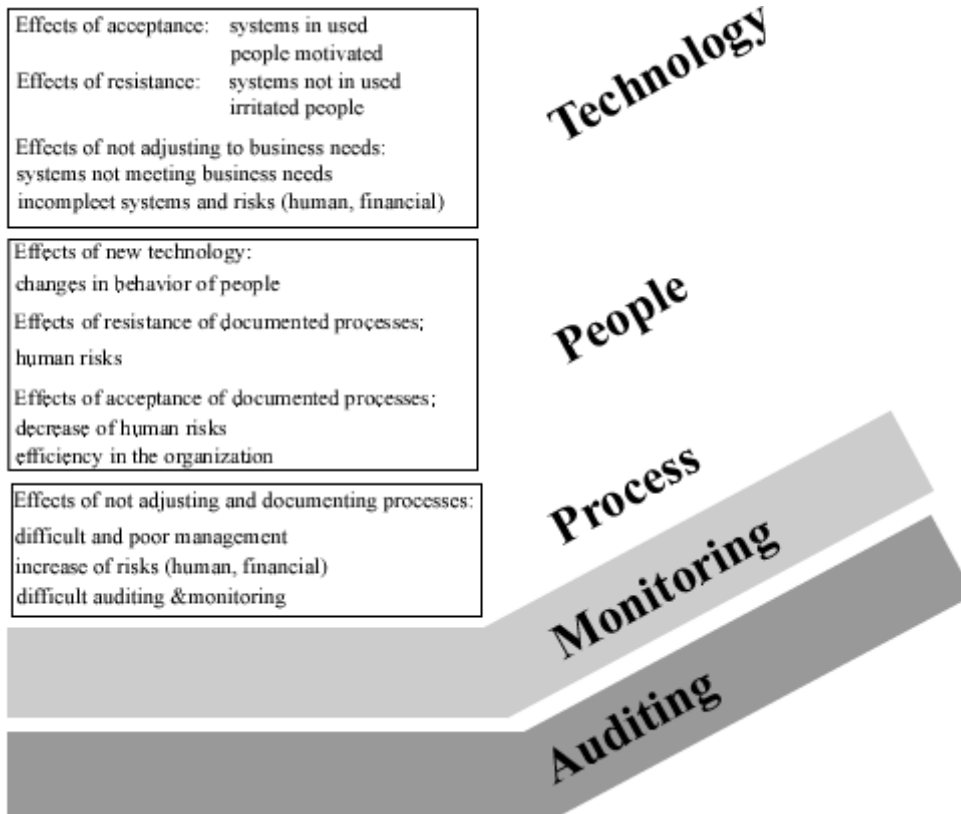

Figure 5-2: Technology, people, processes affect IT auditing

5.3 SOA flexibility is audit complexity

A service-oriented architecture creates flexibility for organizations. SOA reduces the technical complexity so systems can freely communicate with each other. This creates flexibility for the organization; they can now act fast on market changes. What organizations are not aware of and sometimes also auditors, is that this flexibility creates a complex environment for auditors. In a SOA environment the life cycles of services are short, because they are being changed constantly. This is why a SOA environment can be considered as a dynamic environment. In the audit world there is no standard that is based on auditing a dynamic audit environment. A dynamic audit environment has effects on the timing, scope and results of the audit. It makes it difficult for the auditor to set his scope and results, while changes occur constantly. This will be a time consuming process and it is

one of the challenges of an IT auditor in a SOA environment. Two interviewees mentioned this characteristic of a SOA environment.

Other challenges for an IT auditor in a SOA environment are described in table 5-2.

Challenges	
Not enough literature and experience in auditing SOA	Because there is not enough literature and experience in auditing a SOA it is difficult to say how a SOA should be audited. An auditor in a SOA environment will have to do this on his own.
SOA is not a monolithic environment	For years auditor are used to audit a monolithic IT environment, i.e., one systems in one company. New systems are based on the internet technique and the standards have not been adjusted. Some interviewees pointed out that there is a need for audit standards based on architectures and classification of systems.
Technical aspects in SOA	Technology is changing and so are the techniques that are used. The auditor will need skills and knowledge to be able to understand the complexity of technical aspects in a SOA.
Risks	SOA is a different architecture and it will have other risks. There are more parties involved in the environment, which means that risk analysis will have to be done from all parties' perspectives. The reduction of technical complexity, i.e., no technical boundaries, creates other risks in a SOA and the auditor must be able to identify those.
Determining an audit scope	Because a SOA environment has a lot stakeholders involved, thus a lot of services, legacy applications and other components, determining an audit scope will be difficult.
Not enough audit capacity	Auditing every service in a SOA will be a time consuming process and it might be considered impossible to audit each service. This is why the auditor needs to approach the environment differently than a traditional environment in order not to lack in audit capacity.
SOA is process-oriented	Audit is still focusing on output. This will have to change, as SOA consists of services based on business processes. This means that the auditor will have to follow a process; how it runs and if there are no interruptions during transactions.

Service Level Agreements	SOA has SLAs, which describe the relation between services and stakeholders, roles and responsibilities of stakeholders, obligations and other information. The auditor must be able to understand and review the SLAs.

Table 5-2: SOA challenges

5.4 Effects of changes on IT auditing

That SOA challenges the IT auditor is described previously. Technology is developing fast and there is still a monolithic audit program. IT auditing will need to change in order to be able to audit new IT technologies. Most of the interviewees stated that the future of IT auditing will be different. Changes will occur in the IT audit profession, in organizations and in the education for auditors. The following table 5-3 presents the changes, which will have effect on the future of IT auditing:

Changes in IT auditing education	Because technology is getting smarter and more complex it will be necessary for the IT auditor to have technical knowledge on the new techniques that will be used.
Changes in IT auditing	The effect of adjustments in IT audit education might be more specialties in IT auditing. Because new environments will be more complex it might be that an audit will be multi-disciplined, i.e., more auditors in one audit with their own specialty. As more research will be done on, e.g., SOA and IT auditing there will be more literature and experience and this will create possibilities for auditors and profession organizations to think about standards or frameworks for auditing new technology. The focus on human aspects will increase, because IT environments are becoming complex and the auditor will also have to depend on the people of an organization during an audit. Rules, regulations and legislation are emerging because the current economic situation and also because of new technology. They will drive IT auditing. Through compliance auditing might be mandatory in some organizations.

	The fact that organizations will invest more in IT auditing will make that the added value of the IT auditor will increase. The IT auditor will also have to prove his abilities in new IT environments. Because organizations will be aware of the added value of IT auditing, the auditor will also focus more on efficiency and effectiveness of systems and environments. This might lead to more validation, i.e., auditors will also look if the right system is implemented and not only if the system is implemented well. Security will still be an important quality aspect as well as confidentiality, integrity and availability, which will need auditor's focus.
Changes in organizations	Because of rules, regulations and legislations some companies will invest more in auditing and it will become more important. This will lead to more continuous auditing and monitoring. Another driver to continuous auditing and monitor is the drive of organizations to be in control. The world is changing and organizations can not afford any scandals so they will prove that they have everything in control.

Table 5-3: Future directions of IT auditing

6. Conclusions

6.1 Main findings

How does SOA differ from a traditional IT environment?

SOA differs from a traditional IT environment. Not only is the architecture different, but also the management, processes and the roles and responsibilities of people involved are different. The activities within the SDLC processes are different and the life cycles of services are shorter, because they are being changed constantly, this results in different way of managing changes. At last but not least SOA also differs from a traditional IT environment in the way how it will be audited.

These differences are also mentioned in the literature that is used. By doing a literature study, Butler [2008] describes the differences between SOA and traditional architectures and he also mentioned three characteristics of a SOA (process-oriented, short life cycles and message oriented). Haines [2007] also explained that SOA will bring changes in developer skills, roles, tools, processes and organization culture. The changes in SDLC activities are highlighted by Lewis et al. [2008].

Is the SDLC process an important process for organizations and IT audit?

The system (software) development life cycle process is an important process through the development of systems. This process is important because it guides the organization through a project. During the SDLC process internal controls, such as internal governance controls, application controls, data controls, and management controls can be implemented. This process is being underestimated by organizations. Lewis et al. [2007] state that organizations have misconceptions about the development activities of SDLC process and that organizations believe that developing SOA is not different that traditional IT architecture development. With the differences in activities [Lewis et al., 2008] they explain that organizations must not underestimate the SDLC process in a SOA environment, because changes are needed in SDLC activities for an efficient and effective environment.

How are technology, people and processes related to IT auditing and SOA?
Technology, people and processes are related to each other. Service-oriented architecture can be seen as a new technology here and changes in technology affect the people and processes aspects, i.e., SOA brings changes in people and process aspects within the organization.
As Haines [2007] explains SOA will have impact on the development skills, roles, tools, processes and organization culture. Development skills, roles, tools, and the organization culture are aspects where people are involved. This literature agrees on the fact that technology, processes and people are related to each other and that SOA as a new technology affects the two other aspects.
As Butler [2008] and Hinson [2007] also mentioned, SOA will have effects on IT auditing. IT auditing is a process in which technology, people and processes of the auditee are involved.

What effects does new technology have on the future of IT auditing?
Butler [2008] has suggested some future directions for IT auditing. He also presented a SWOT analysis of IT auditing where some of the opportunities can be seen as future directions. That there are effects of changes in technologies on IT auditing is described in section 5.4 and this only confirms the findings in previous literature.

6.2 Future research suggestions

Future research suggestions related to this research could be:
- Conducting a research on compliance frameworks for a SOA environment;
- Conducting a research on how to perform an IT audit on a service consumer side or the service provider's side, i.e., a SOA audit guide;
- Conducting a research on continuous auditing and monitoring in a SOA environment.

Limitations:
- this research only discusses the reflections of auditors on the impacts of SOA on IT auditing. The interviewees were only questioned on the subjects that give a better understanding of SOA, the effects of it on IT auditing and the attention for change in the IT audit world;
- this research does not include detailed technical explanations of a SOA, the SDLC process and of the IT auditing process.

6.3 Conclusions

By comparing the data analysis with the prior literature, it can be concluded that one of the aspects through which SOA has impacts on IT auditing is the SDLC process. The differences in the SDLC activities will have an impact on the IT auditor's activities. The complex audit environment in a SOA can be approached from different point of views. It will be difficult for the auditor to set an audit scope, to divide his audit capacity and to perform a risk analysis in a dynamic environment. This is the biggest challenge in a SOA environment for an IT auditor. The best solution for this is to have a guideline in place to audit dynamic IT environments. In such a guideline steps need to be defined how an auditor can set his scope and from which point of view the auditor can approach his audit. There must also be audit standards that decrease the audit risk of a not limited audit scope. The audit standard for a dynamic environment must explain the auditor's roles and responsibilities within a dynamic environment like SOA.

Another related aspect discussed in this study is the future of IT auditing. Auditors are aware of changes that are needed to get IT auditing aligned with future directions presented in this research. Auditors will have to spend more time together to discuss these aspects and to come with solutions for the professional organization NOREA in the Netherlands. These future directions must not be neglected and auditors and audit & control organizations must not wait for the influence from outside. This will make IT auditing more mature and the image of auditors will change, because their added value will be known.

It can be concluded that SOA has indeed impact on IT auditing. IT auditing has gained its position in the audit world, but technology is faster than the developments within the IT audit profession. The main findings are based on the importance of the SDLC process and the complex audit environment within SOA for an IT auditor. Up till now the differences and similarities have been described and concluded. This study meets its relevance for IT auditors, by presenting an audit approach for IT auditors. The next approach is not a guideline; it is a recommendation that can be used for setting up a guideline. The approach is illustrated in figure 6-1.
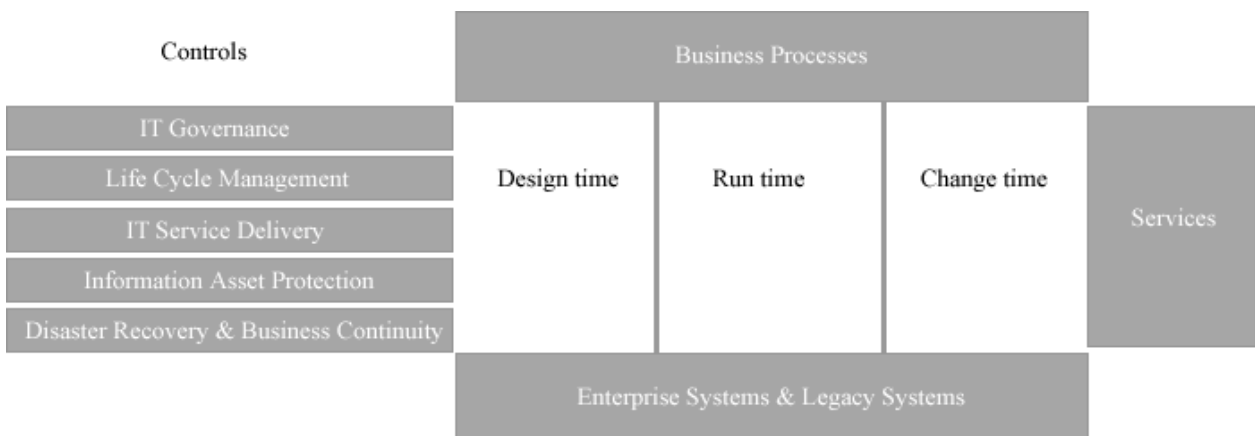

Figure 6-1: Horizontal-Vertical audit approach

A SOA environment consists of business processes, services and legacy applications. Before performing an audit the auditor must first set his scope by looking from whose perspective he will audit the SOA environment; from the service consumer's perspective or from the service producer's perspective. A risk assessment from both points of view must be performed. When preparing an audit the following is very important for an auditor to review:

- the completeness and reliability of the information that arrives in the business process, i.e., information from the service producer;
- the completeness and reliability of the information that is in the legacy system layer;
- the availability and integrity of the services.

By focusing on the business process, the auditor can get an overview which information floats through the process and from that point he can audit the related services on availability and integrity. To be sure whether the right services are being used the auditor can consult the service level agreements and he/she can audit the services in the design time, where the requirements are set. The design time is one of the three stages in a life cycle activities management. The auditor can decide whether he audits the services in design time, run time or change time. In design time the auditor will be able to review the requirements, design and testing phase of the SDLC process, in the run time he will be able to audit how the implementation works and on the availability of the service, and in the change time he will be able to audit on the service management processes.

The auditor must review the services from the business process point of view as well as from the legacy systems layer, when using the above picture as a reference. By auditing the different stages with the life cycle activities, the auditor can set a scope and he can divide his audit capacity or he should consider the possibility of auditing each stage individually. The audit steps involve:

- approaching the audit from a business process point of view, i.e., the scope will consists of the business processes to be audited;
- approaching the services from the three stages: design-, run-, and change time;
- performing a risk assessment on the business processes and services involved.

By using these approaches the auditor will be able to report his findings according to business processes in design time, run time and change time. The auditor can identify risks per business process.
The auditor will be able to review controls within different areas (IT Governance, Life Cycle management, IT service Delivery, Information Asset Protection and Disaster Recovery & Business Continuity) also in the three stages. This represents a horizontal and vertical audit approach.

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