The adaptive enterprise

Defining architecture principles for an adaptive enterprise

MSc Thesis of Bas Verbruggen

Colophon

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Preface

This thesis concludes the master research that I have carried out at the research group for Information Retrieval and Information Systems under supervision of prof. dr. Daan Rijsenbrij. The research project has been carried out over a period of 6 months, from September 2004 until the end February 2005.

I would like to thank several people and companies who have contributed to the successful completion of this research project. In special, I would like to thank my supervisor prof. dr. Daan Rijsenbrij for his enthusiasm and useful comments. Secondly, I would like to thank my other supervisors Rob Kruijk and dr. Erik Barendsen, for their advice and comments during the project.

Lastly, I would like to thank the following enterprises, or representatives of those enterprises for their contribution to the research project: Leo Laverdure (HP), Jaap Schekkerman (Cap Gemini), Ron Tolido (Cap Gemini), Danny Greefhorst (IBM), Willie Appel (MetaGroup), Bloemenveiling Aalsmeer, Belastingdienst, ABN Amro, Bizz Design, Ordina, Oracle, Unisys and ABP.

Bas Verbruggen, Nijmegen, May 19, 2005

Table of contents

Management summary

The goal of this research project was to identify the main principles of an adaptive enterprise. Several providers of IT services have started adaptive enterprise programs to show the world how they think an enterprise should become flexible and agile. These programs have functioned as important input for the research project. Another category of input has been the experiences of organisations with characteristics of an adaptive enterprise in practice.

Why is it important to be adaptive? In order to survive in the current ecosystem, an enterprise has to be able to react quickly and effectively to threats and opportunities in the ecosystem. Threats and opportunities can arise in different forms and can be different in nature, also depending on the kind of enterprise. Threats and opportunities can for example originate from competitors, customers, partners or the government. For an enterprise it is important to react to these changes as fast as possible in order to be ahead of competitors in the process of creating value.

With use of the IT service providers, a set of 15 principles have been set up, to which an enterprise should comply in order to be adaptive. These principles vary from nature (strategic, tactical, operational) and the level in the enterprise to which they apply. The area of application can either be the business layer, information layer, application layer or infrastructural layer.

Strategic principles tend to focus more on the creation of awareness on why where, and when adaptivity is needed. The tactical and operational principles focus on the actual execution of the adaptive capability. The IT service providers have not been used to prioritise these principles, a survey carried out under several customers of these IT suppliers has been the primary input for that.

The main result of this research project is that an adaptive enterprise should focus on strategic principles that validate and give the direction to the creation of adaptive capabilities. Being aware of where in the ecosystem value can be created and how the enterprise is going to anticipate, has been perceived as the most important characteristic of an adaptive enterprise. If an enterprise does not have this characteristic, executing operational and tactical principles, like *integration* and *modularisation* of applications and infrastructure, are far more difficult to realise. Creating value by innovating, either by creating new products or by optimising internal processes or by adopting a new business model has been regarded as the most important tactical principle.

A complete list of the principles that are of importance to an adaptive enterprise can be found in chapter four. The experiences with these principles in practice are described in chapter five.

Samenvatting

Het doel van dit afstudeerproject was om de belangrijkste architectuurprincipes van een adaptieve onderneming boven tafel te krijgen. Verschillende consultancy bureaus zijn met een 'Adaptive Enterprise' programma gestart om hun visie over flexibele en slagvaardige ondernemingen aan de man te brengen. Deze visies vormden een van de twee belangrijke pijlers voor dit onderzoek. De andere pijler werd gevormd door de mening van bedrijven in de praktijk ten aanzien van de belangrijkste karakteristieken van een adaptieve onderneming.

Waarom is er tegenwoordig de noodzaak om over adaptief vermogen te beschikken? Om in de vluchtige en sterk competitieve economie van tegenwoordig te kunnen overleven, is het zaak om zo snel en efficiënt mogelijk op veranderingen in te kunnen spelen. Veranderingen kunnen zich voordoen in de vorm van kansen en bedreigingen. Dergelijke kansen en bedreigingen kunnen zich bijvoorbeeld voordoen op het gebied van klanten, leveranciers, partners of bijvoorbeeld de overheid. Het is voor een onderneming zeer belangrijk om er snel bij te zijn, het liefst sneller dan de concurrentie. Alleen op deze manier kan een onderneming waarde creëren.

Met behulp van verschillende consultancy bureaus is een 15 tal principes opgesteld, waar een onderneming aan kan voldoen, wil het adaptief zijn. Deze principes kunnen verschillend van aard zijn en kunnen betrekking hebben op verschillende lagen in een onderneming (business tot infrastructuur). Een principe kan strategisch, tactisch, of operationeel van aard zijn. De lagen waarop een principe betrekking kan hebben zijn: de bedrijfsprocessen, informatie, applicaties, en infrastructuur.

Strategische principes richten meer de aandacht op het bewustzijn *waar* en *wanneer* adaptief vermogen noodzakelijk is. Tactische en operationele principes geven meer aandacht aan de daadwerkelijke creatie en toepassing van adaptief vermogen. De consultancy bureaus is niet gevraagd om de principes van een adaptieve organisatie te prioriteren, dit is gebeurd door de principes voor te leggen aan de klanten van deze leveranciers. Dit zijn uiteindelijk de partijen die hier het meest ervaring mee hebben.

De belangrijkste uitkomst van dit onderzoek is dat een adaptieve onderneming zich primair zou moeten focussen op een aantal strategische principes die er voor zorgdragen dat een onderneming op een verantwoorde en juiste manier adaptief vermogen creëert. Een onderneming moet zich bewust zijn van waar in het ecosysteem waarde gecreëerd kan worden en hoe de onderneming hier mee omgaat. Zonder de vertegenwoordiging van verschillende strategische principes in een onderneming is het zinloos om andere tactische en operationele principes te verwezenlijken. Het uiteindelijk creëren van waarde door te innoveren, dit door of nieuwe producten te creëren of bestaande processen te verbeteren of andere klantbenaderingen, is aangemerkt als belangrijkste tactische principe.

Een complete lijst van principes die van belang zijn voor een adaptieve onderneming staat beschreven in hoofdstuk 4. Hoe deze principes in de praktijk tot zijn recht komen, staat beschreven in hoofdstuk 5.

1 Introduction

This chapter gives an overview of the structure of the research project and its validation. The questions that will be answered within this chapter are:

- Why is this research needed? (paragraph 1.1)
- What is the goal of the research? (paragraph 1.2)
- What are the research questions that need to answered? (paragraph 1.3)
- What is the structure of the research? (paragraph 1.4)
- What can the reader expect from the remaining chapters within this thesis? (paragraph 1.5)

1.1 Problem statement

1.1.1 Problem area

Because of several market changes that are described in the next chapter, there has been an increase of pressure on IT departments within enterprises to increase performance and focus on quality aspects. Simultaneously, they had to focus on cost reduction in order to survive. Performance had to be increased to do more in less time.

1.1.2 Problem statement

IT service providers offer solutions for a more flexible and efficient IT department as well as entire enterprises. This resulted in several definitions as well as (partial) solutions for an agile [1]and efficient enterprise, the so-called adaptive enterprise. The definition of an adaptive enterprise will be extensively treated in chapter 4, however for now the following definition is given:

An adaptive enterprise is an enterprise that can determinately react with speed, ease, and efficiency to relevant changes that occur within the ecosystem it resides in.

The problem statement for this research project can therefore be formulated as follows:

IT service providers keep a large variety of definitions, and therefore perceived characteristics, for an adaptive enterprise. There is no common interpretation to the exact meaning of an adaptive enterprise and the capabilities it should have

1.2 Goal

The goal for this master research project can be formulated as:
Identify the essential capabilities for an enterprise being adaptive. Formulate these characteristics in terms of architecture principles, architectural rules and architectural guidelines.

The characteristics of an adaptive enterprise are formulated as architecture principles, because principles have several advantages. They are holistic, originate from an

[1] The ability of an enterprise to respond quickly and easily to market changes

enterprise strategy, and should therefore last for several years [RIJS02]. Becoming adaptive is a long and difficult process that needs to find guidance in principles that give direction for the transition. More information on characteristics and advantages of architecture principles can be found in the third chapter of this thesis.

1.3 Research question and sub questions

The above-described goal is achieved by answering the full research question.

What are the essential requirements to which an IT intensive enterprise has to comply in order to be adaptive to changes in the ecosystem? These requirements will be formulated into several architectural principles

This question embodies several concepts, which require some clarification.

Essential requirements
Requirements are essential when the absence of the requirement leads to complete or partial failure of the strategy and vision from which it originated.

IT intensive enterprise
An IT intensive enterprise is an enterprise, whose primary processes depend heavily on the availability and accuracy of information systems, and thus the information systems are essential for making profit. At the same time this implies a narrowing of the research area. Every system in the world, either a human being or an organisation shows some adaptive behaviour. Therefore, some clarification is needed about this narrowing. Only IT intensive enterprises are used within the scope of the research. Other enterprises or organisations that can show adaptive behaviour like religious organisations are not used within this scope.

Ecosystem
An ecosystem can be defined as follows: a biological community of interacting organisms and their physical environment [HEN01]. Translated to the world of enterprises, an ecosystem can be defined as everything an enterprise interacts with or depends on. This can be anything in the range of competitors, customers, suppliers, employees, but also geographical, social, or political dependencies

Changes in the ecosystem
Changes in the ecosystem can be defined as changes in the way an enterprise communicates with or depends on other entities [2]in the ecosystem. The next chapter describes the kinds of changes that can occur and how they manifest themselves.

Architecture principles
We have come across the word ‘architecture’ several times now. However, what exactly does architecture mean in this report and what is its function? In the context of this research performed in the field of digital architecture, it is important to have a clear understanding of architecture.

[2] Entities can be defined as other enterprises, suppliers, customers and governments.

Many distinct definitions concerning digital architecture are used within the business today. Despite these differences, most definitions embody one important thing: the optimal alignment between business processes, information, applications, and infrastructure. The definition of digital architecture obtained for this thesis is the following:

Digital architecture is a coherent and consistent set of principles, particularized to concerns, rules, guidelines, and standards which describe how an enterprise, information services, applications and infrastructure are designed and is perceived in its usage. [RIJS04].

According to [RIJS02], architectural principles must have the following characteristics:

- Principles should address to a fundamental idea, to fulfil a common requirement;
- Principles originate from several ecosystem factors and personal interpretations, these can be:
  - Government regulation;
  - Social trends;
  - Industry conditions;
  - Industry evolutions;
- Principles from the enterprise itself:
  - Mission statement;
  - Vision;
  - Strategy.
- It should be possible to translate a principle into guidelines, rules, and standards.

Chapter three features a paragraph where the use and purpose of architecture principles is clarified.

The research question is too comprehensive. Therefore, two sub questions have been defined that need to be answered first in order to answer the overall research question.

Sub question 1:

What are the essential requirements to which an IT intensive enterprise has to comply in order to be adaptive to changes in the ecosystem, according to the providers of IT services? These requirements will be formulated into several architectural principles

This question focuses on retrieving all possible aspects of adaptive enterprise. To get a clear view of which characteristics are important and have been proven effective, a second sub question is defined.

Sub question 2:

How are the main architectural principles, resulting from sub question 1, being brought to practice and what are the experiences with these?

This question is used to validate and prioritise the principles retrieved from the first sub question. The principles are prioritised according to their importance for the adaptive enterprise.

1.4 Research structure

The research project is divided into two main phases, one phase for each sub question. The sub questions are answered consecutively, after which the main research question can be answered. The following two phases can be recognised:

1. In order to answer the first sub question, the following two things have been done. First, with the use of literature, and interviews all possible principles for an adaptive enterprise have been formulated. The second action has been to construct an overview of the several definitions the IT service providers keep on the adaptive enterprise. The IT service providers approached for this part are Capgemini, HP, IBM, and the META Group.
2. By means of a survey a prioritisation has been given to the principles defined in part one. A prioritisation of which principle is of most importance for an adaptive enterprise. The survey is performed with the use of the customers of the IT service providers. These customers are all member of the Dutch Architecture Forum.

After these two phases, the results have been analysed and interpreted. This process resulted in answering the main research question. In figure 1-1; a graphical representation is given of the research structure consisting of the main phases and deliverables.

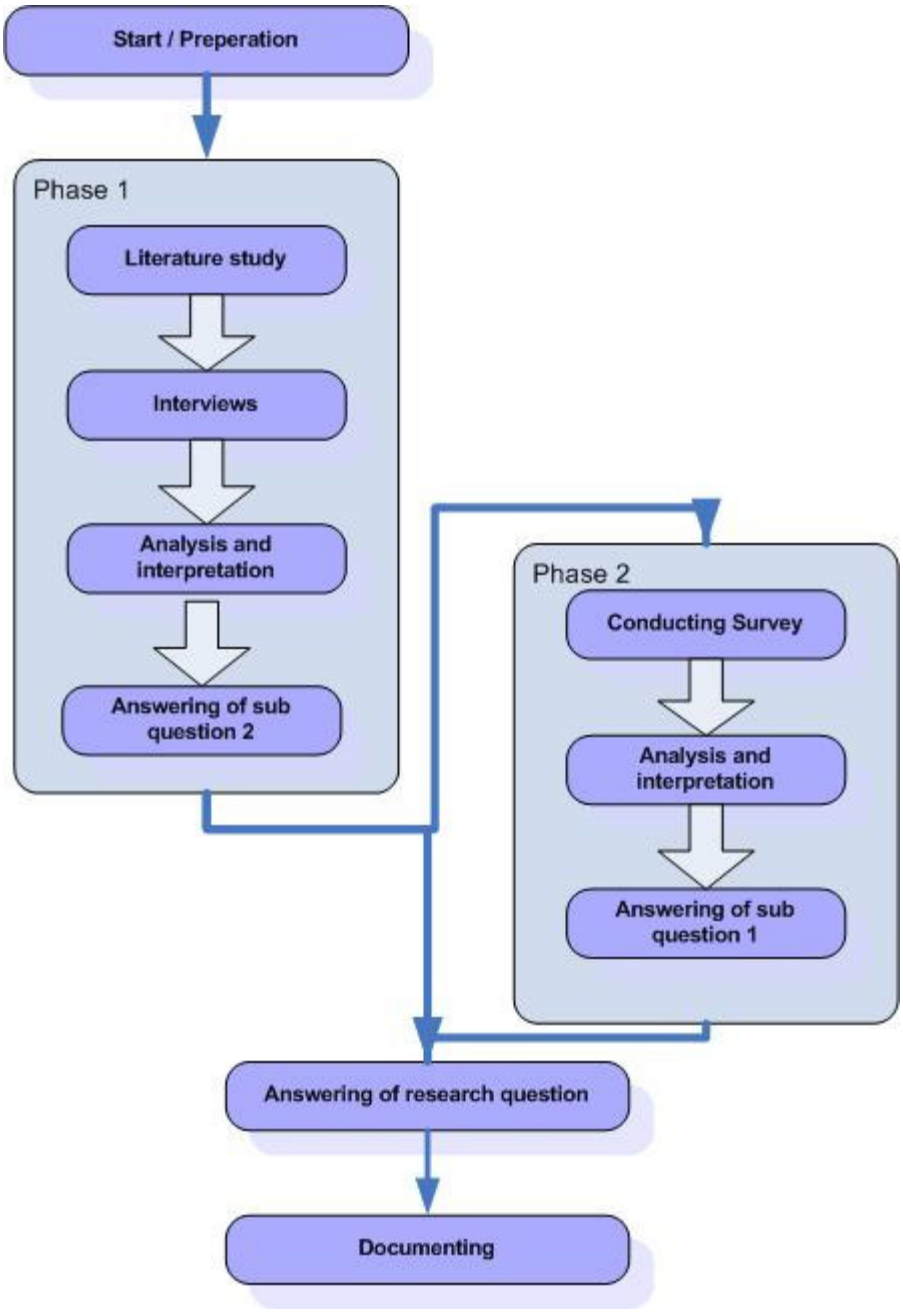


Figure 1-1 Research structure

1.5 Research methodology

The methodology applied for this research mainly consist of empirical work. In the beginning – during the first month - literature has been mostly used to build an understanding of the concept of the adaptive enterprise. This has created a basis for the subsequent interviews, which has been used to construct questions and subjects, functioning as the main line throughout the interviews.

Interviews have been carried out with architects, strategists, and visionaries from the companies mentioned above. Each interview was set up uniquely for each company or executive, ensuring all relevant information was obtained.

In addition to these interviews, other forms of data collection have been used during the first phase of the research project. These events where the HP Dutch World Conference and the Dutch Architecture Congress.

During the second phase of the research project, the empirical work was mainly used to retrieve information. A survey has been carried out among several IT intensive organisations to validate and prioritise the output from phase 1, according to their importance for an adaptive enterprise.

1.6 Structure of the thesis

Chapter two - *the need for an adaptive enterprise* - focuses on the validation for the research. Why is the capability of being adaptive, agile, and flexible so important nowadays? In addition, what are changes an enterprise can be confronted with? Chapter two will end with a summarisation of the areas where adaptive capability is most required. This chapter is required to get a better understanding of the relevance of the research question.

The third chapter – *positioning architecture principles* - focuses on the framework that is used for the positioning of architecture principles. It describes what the framework consists of and the reason for choosing this framework.

Chapter 4 – *principles for an adaptive enterprise* – contains the answer to the first sub question. First, an overview is given of the different definitions of adaptive organisation according to the IT service providers. These definitions will be criticised and commented on, after which a personal definition for this thesis will be given. The main characteristics of an adaptive enterprise have been defined using these definitions.

The fifth chapter – *applying principles to business initiatives* - will focus on the answer of the second sub question, namely. 'What are the experiences with adaptive enterprise principles in practice?' The main characteristics of an adaptive enterprise will be mapped to the areas where changes, mentioned in chapter two can occur.

The main conclusions of the research project will be summarised within the last chapter, together with the answer to the main research question. Besides these conclusions, some comments are given on the current position of the adaptive enterprise concept in today's business and its relationship to phenomena like the intelligent enterprise.

Finally, this thesis contains an extensive glossary where several definitions and concept are clarified.

2 The need for an adaptive enterprise

Throughout almost every industry, enterprises have seen the notion of changing their business in order to better serve their customers and increase their profits. Business structures needed to change, to react faster to customer demands and other market changes. This chapter will provide answers to the following questions:

- What are the market changes that have taken place throughout the last 30 years? (paragraph 2.1)
- What is the importance of reacting fast and flexible on changes? (paragraph 2.2)
- What are the challenges enterprises are confronted with? (paragraph 2.3)

2.1 Historical perspective

2.1.1 Market changes throughout the last 50 years

The most important change we can recognise over the last decades is the increase of volatility. Everything between customer-demand to competitive pressure has increased in speed. This trend has several causes. In the literature for this research project, several causes have been mentioned for this phenomenon. In the table 2-1 below, you can see some of the major and small changes that have occurred, some IT related others not.

Market	***Customers***	***Product***	***Technology***
From large industries to small industries.	Long-term customer relationship to short term customer relationship.	Long product lifecycles to short product lifecycles.	Technology as luxury to technology as major dependence.
From a stable (predictable) market to a dynamic unpredictable market.	Expectant to demanding. Customers say what they want, not buy what they are offered.	Long Time-To-Market to short Time-To-Market.	From oddity to commodity. People do not notice technology anymore.
From local markets to global markets. Globalisation (Tendency toward a worldwide investment environment, and the integration of national capital markets.)	From predictable to unpredictable. Customers are better informed then before, and can demonstrate more unpredictable behaviour.	From mass production to Just-In-Time manufacturing.	From computer based applications to web applications.

Table 2-1 Significant changes during the last 50 years

Halfway through the 20th century most enterprises had stable relationships with their customers, suppliers, and competitors. An enterprise could develop and produce products with long-term foresights. Market analysis and stable customer relationships gave enterprises the opportunity to predict what a customer would want over a year from now. Regarding suppliers, an enterprise usually had to accept those that were suitable from a geographical perspective. Companies had large trading and selling areas for their products of which they knew they were not going to change very much. For example, light bulb manufacturer Philips knew that its customers would still buy its products in 2

years from now. There were no other competitors, or simply stated, changes in the market that would have made Philips worry about its future.

All this changed when the entire global market became more connected [SCHEK01]. Through increase of communication technology and logistic excellence, a manufacturer now had the opportunity to get cheaper components from suppliers elsewhere. Manufacturing moved to 'Just in Time' when it was evident that producing large quantities of products on stock was getting too expensive. The dependence on geographical level decreased. Simultaneously, enterprises got the opportunity to reach other markets, even in other countries.

2.1.2 Power of the customer

This increase in connectivity also triggered another event near the end of 90's; the increase of powerful and informed customers. Because of globalisation of the market, customers had the opportunity to choose between products from all over the world. They became more demanding, it was not self-evident anymore that they would stick with their traditional suppliers [CHAD04]. Enterprises were forced to create competitive advantage by reducing costs or innovating[3]. Reducing time-to-market was for some companies inevitable. An example of a short time-to-market (TTM) is that of cloths manufacturer and seller Hennes and Mauritz (H&M), which has a TTM of drawing table to local shop of just 6 weeks. This enables H&M to react fast to the demands the customer implies.

The introduction of the internet even boosted this trend, giving customers more power. This is clarified in the next paragraph.

2.1.3 The internet revolution

With the introduction of the internet, all enterprises in the ecosystem became even more interconnected [DIAN04]. Customers were able to shop online at stores all over the world. They could check the lowest holiday prices and subsequently book online without interference of any human being. The result was that traditional travel agencies have been confronted with dramatic loss in market share [CHAD04].

With use of intra- and extranet technology, enterprises can communicate in real-time with their suppliers all over the world and have the possibility to cater to changes instantly [IBM04].

Overall, can be said that the increase of connectivity, by means of the rise of the internet, triggered two important trends. First of all, globalisation of the world market. Giving enterprises the opportunity to supply and deliver products and information all over the globe. Secondly, an increase of power of the customer. The customer dictates what the requirements are for a certain product or service. If he or she is not satisfied, a new supplier can be chosen instantly. This illustrates the need for a product or service base that seamlessly satisfies the needs of the customers.

2.2 Need in the information age

The increase of the use of technology mentioned above has also created many challenges. Challenges that in turn emphasise the need for flexible and agile enterprises.

[3] Innovation is defined as the introduction of a new idea into the marketplace in the form of a new product or service, or an improvement in organisation or process. [ZIS04]

This paragraph clarifies the need for an adaptive, flexible enterprise in the information age. The *information age* can be defined as follows:

> *A period of activity starting in the 1950s and continuing today in which the gathering, manipulation, classification, storage, and retrieval of information is central to the workings of society. Information is presented in various forms to a large population of the world through the use of machines, such as computers, facsimile machines, copiers, and CD-ROMs. The Information Age was enhanced by the development of the Internet, an electronic means to exchange information in short periods of time, often instantaneously [ITEA].*

With this definition in mind, it is easier to comprehend the information in the subsequent paragraphs.

2.2.1 The increasing amount of information

With the introduction of many information technology solutions, like the internet, business applications (for example ERP or HRM systems) and office applications, the amount of information has exploded. An increase of relevant information as well as an ever-greater increase in irrelevant information. This makes it harder to retrieve the information you want. For enterprises, it is a challenge to have good business intelligence[4] in order to turn this stream of data into meaningful information. Therefore, search engines, data-mining techniques[5], and agent technology are extremely important to retrieve meaningful information from this amount of data.

The appearance of Radio Frequency Identification (RFID) and the Global Positioning System (GPS) also leads to an increase of information powered goods, services, and processes. RFID enables warehouses to get more information and thereby control of their goods. GPS has turned out to be of irreversible value for logistic services. The dependence on information is ceaselessly growing [CHAD04].

The last few years, changes have taken place in the ways people access information and by means of which medium. Not only computers, but also mobile devices have found their way to the internet. This has led to great implications for enterprises, presenting information on their products not only 24/7, but also with the use of different media [DIAN04].

2.2.2 An immature field of industry

Another challenge in the information age is to deal with the cumbersome and complicated legacy systems created by the first automation of human processes. In the 60's and 70's there were no formal software development processes or ISO standards to comply to. Quick automation of former processes carried out by humans, was the main driver, focussing on short-term requirements and quick wins. Enterprises forgot to think about the future, or to take things like ease of maintenance or documentation into account [IBM04].

The industry of information technology is still maturing and therefore constantly confronted with its own shortcomings. IT organisations are optimising infrastructure, applications, and processes to meet changing business requirements. Legacy systems

[4] Business intelligence (BI) is a broad category of technologies that allows gathering, storing, accessing and analyzing data to help business users make better decisions.
[5] Data mining is the process of analyzing data to identify patterns or relationships. [IOMEGA]

however prevent enterprises from making quick changes or adapting to changing business needs. Dismantling them is therefore necessary in order to make substantial progress in creating a more flexible organisation [FER03].

Another aspect organisations are confronted with is the complexity of their IT infrastructure. Through years of IT development without an integral approach, complexity has grown enormously. Numerous small IT initiatives with the aim of short-term profits and advantages have generally not contributed to transparent IT organisations [CHAD04].

This phenomenon has had another implication; computer platforms have become widely distributed and vertically isolated. IT solutions, from applications to infrastructure have been designed and implemented for vertical departments. This has resulted in inefficient use of data, storage capacity and processor capacity. According to [GUT03] the utilisation of current IT infrastructure is far from optimal:

- Most of the mainframes are idle 40% of the time;
- UNIX servers are idle 90% of the time;
- PC's 95% idle of the time.

This underutilisation and complexity of IT infrastructure has its direct effect on the break down of the IT budget. Just trying to make technologies work together and maintaining current systems takes up to 40% of the IT budget. Half of IT costs are thus spend on things that do not directly drive value.

Resulting from the challenges above, an additional challenge can be formulated: governance. All this complexity, underutilisation and the eventual migration to a new situation requires significant governance. Governance of current IT systems is important as well as the migration to a new situation. If an enterprise cannot control it, it will not get to this new situation.

2.2.3 Economy

In conclusion, there is another important factor why there is so much attention to adaptivity, flexibility, and efficiency: economic circumstances. Because of the recession that has been going on for the last 3 years, companies have realised that current approaches towards customer relationships and competitive advantage were not sufficient anymore. Listening to customers and looking out for competitors became even more important in order to differentiate from others, and consecutively create value.

2.3 Events in the ecosystem on which to respond

2.3.1 Definition of change

Before clarifying several events that require an enterprise to obtain adaptive capability, the term *change* will be clarified.

What does change mean in relation to business? To make it more tangible you could say that changes can arise in the forms of events that can either be a *threat* or *opportunity*. This leaves us with clarifying the concepts of *threat* and *opportunity.*

The Oxford dictionary defines *threat* as:

a stated intention to inflict injury, damage, or other hostile action on someone'

Or

'the possibility of trouble or danger'

This definition states that 'something' could happen (you are not sure what) which could have a negative effect.

The Oxford dictionary defines *opportunity* as:

'a favourable time or set of circumstances for doing something'

Threats and opportunities constantly come and go. It is however, a challenge for an enterprise to recognise the changes that are significant and translate these changes into a *concern*. In an ecosystem, change is happening all the time, sometimes changes might occur that have a direct impact on your system. Sometimes changes occur that do not directly affect you, but turn out to have a negative impact in the long term when no appropriate action is taken. This requires the presence of sufficient business intelligence.

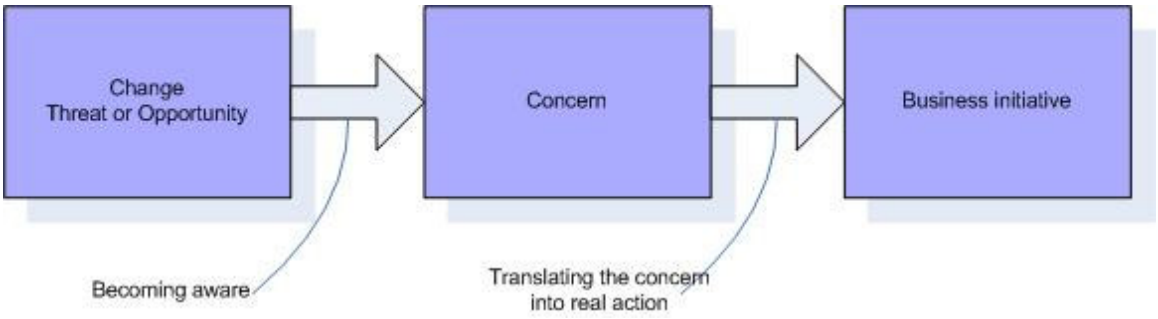


Figure 2-1 - The relationship between Change, Concern, and Business initiative

One of the meanings the Oxford dictionary gives to *concern* is '*a matter of interest or importance*'. This is an appropriate meaning for *concern* in the current context. An enterprise should have the intelligence to recognise the importance and impact of a certain threat or opportunity for its business. If it does, it will be able to react to the change and possibly tackle its intended consequences that would have occurred otherwise.

When the concern is fully recognised, it will function as input for a business initiative that in its turn will provide the real answer to this change. A business initiative can take the form of a project, business decision, or for example the launch of new marketing campaign. It is up to the business initiative to react to the change in such a manner that it creates competitive advantage or value for the enterprise.

The relationship between a business initiative and a principle is as follows. One or more principles give direction to the completion of the business initiative. The principles define the boundaries in which the solution of the business initiative is shaped.

2.3.2 Changes

In today's business, changes can occur with a wide variety of origin and impact. The list below illustrates several changes. Note that this list is indicative and does not have the aim to be complete.

Business

- Appearance / disappearance of competitors;
- Appearance/disappearance of suppliers;
- Joint ventures, including others and yourself;
- Off-shore activities of others or yourself.

Social, political, natural

- Earthquake;
- Terrorists threats; 9/11 challenged enterprises all over the world;
- War;
- Hypes and trends within the society;

Customer/Product

- Changing customer demands;
- Changing quality requirements;
- Introduction of similar products by competitors;

Legislation

- Introduction of new laws and regulation. (Sarbanes-Oxley)

2.3.3 Classification of events

There are several ways changes can be classified. For example, you can have internal or external changes, changes in competitors, changes in the environment, etc. For this research, in dialog with some professionals, several key areas are defined in which changes can occur. These areas are of great importance for today's business.

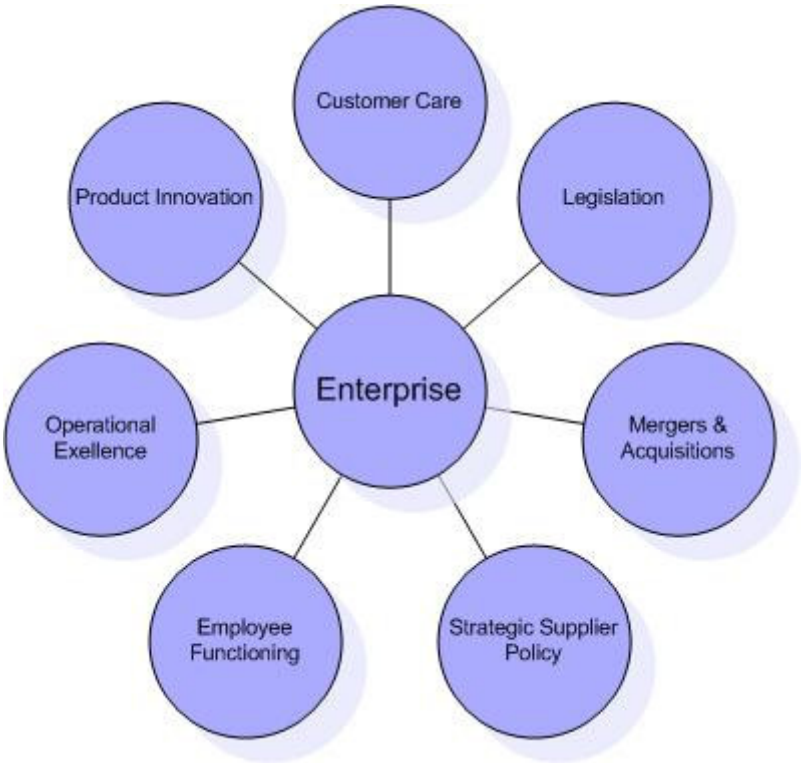


Figure 2-2 - Business Initiatives Areas that are most important for enterprises today

Changes occurring in the *social, political,* and *environmental* category are not taken into account into this classification. Change within this category can have great impact on an enterprise, but taking this category into account would have broadened this research too much. It is up to other fields of study (like social and political studies) to consider changes within these areas.

Within these areas, threats and opportunities, concerns and subsequently business initiatives take place. These business initiatives are a reaction to the threat or opportunity. Because the business initiative is the most important action in this, these areas will be called business-initiative-areas. Each area will be clarified.

Customer care
Changes related to customers can be found in this area. Changing customer needs or a changing customer base are examples.

Legislation
This area encompasses changes that occur regarding legislation and compliance. This can be from governmental as well as EU or WTO like organisations. Governmental laws like the Sarbanes Oxley, Clinger-Cohen act and several European laws, oblige companies to be open and transparent to the outside world.

Mergers and acquisitions
This area focuses on the threats and opportunities that can arise after mergers and acquisitions. Mergers and acquisitions that involve the enterprise itself, as well as those in which other enterprises are involved.

Strategic supplier policy
This area mainly focuses on the strategic connections an enterprise can have with other enterprises in the ecosystem. This area is sometimes referred to as *sourcing strategy*. It is about thinking of strategic connections with suppliers, partners or customers. An example of a strategic initiative could be the in or outsourcing of certain activities.

Employee functioning
All changes involving employees are embodied within this area. As the most important asset of an enterprise, an employee should have the means to function as optimal as possible. Having all required information and tools at their disposal as well as feeling as pleasant and comfortable in their work.

Operational excellence
This area pays attention to internal changes within an enterprise. Think about changes that might occur towards processes, applications or infrastructure. In addition, optimisation issues play an important role here, like server or storage optimisation.

Product innovation
Products are very often subject to change. Changing quality requirements or competitors that introduce a concurring new product can be seen as examples within this area.

2.4 Conclusions

The information age has been characterised by changes. Changes that mostly had their origin in the rise of technology in general, and information technology in particular. The most important change can be characterised as the globalisation of the world economy. People do not have to buy their books at the bookshop around the corner anymore, but can buy online in the country where the book can be found for the lowest price. Enterprises can have extensive business connections with suppliers all over the globe as it can have connections with suppliers in the same country.

All these changes resulted in the rise of several information technology solutions in order to hook on to these changes. Not always have these solutions appeared to be efficient in the long term. The existence of legacy systems prevents enterprises from making quick changes to their application infrastructure in order to react to market changes.

Within this era of information technology, an enterprise can be confronted with several changes to which it can be required to respond. These changes can either arise in the form of threats or opportunities. With the use of business intelligence, these threats and opportunities have to be judged and eventually translated to concerns. Concerns can subsequently be input for a business initiative.

These business-initiatives-areas are going to be input for chapter five, in which solutions for adaptive capabilities are found for each of the business-initiative-areas.

The adaptive enterprise needs to answer to the challenges IT organisations are faced with today: complexity, control, costs and change. What the essential ingredients are for this answer is the goal of this research project.

3 Positioning architecture principles

In this chapter, the framework in which the principles of an adaptive enterprise will be positioned is discussed. The questions that will be answered are:

- What is the motivation for a framework, and this framework in particular? (paragraph 1)
- What is the relationship between frameworks and architecture? (paragraph 1 + 2)
- What are the dimensions and values that can be recognised within this framework? (paragraph 3)

This chapter facilitates the understanding of the answer to the main research question, and the first sub question in particular.

3.1 Why use a framework?

This paragraph discusses the background, purpose, and validation of using a framework

3.1.1 Introduction to frameworks

In the physical world, architecture is used to classify, group, and simplify artefacts in order to construct profound and solid buildings in which people enjoy working. In the world of IT, it has been a challenge to simplify and structure processes and information systems to accomplish that same goal.

The last 10 years have appeared to be a decade in which the major providers of IT services were searching for the best way to shape their vision on architecture. Especially the creation of the enterprise architecture mindset has led to the creation of many architecture frameworks.

A framework consists of several dimensions to which the artefacts of an architecture can be classified. When designing a home, you would also begin with a floor plan by grouping related functions and items into rooms. For instance, you would position the sink and the stove in the same room. It would not make sense to put the stove in the same room as the bathtub. In the IT world, the same goal is accomplished by grouping related data and processes into coherent information systems [COOK96].

3.1.2 Simplification

One of the aims of digital architecture is to simplify, making it easy to reason and communicate about the artefacts that an architecture describes. However, where does this need for simplification come from? The ancient Greek studied information processing to attempt to simplify their world and understand their environment. They had a uniform approach to information and knowledge processing. Nowadays, individualism can be indicated as the main catalyst behind an autonomous approach to information systems and information processing. The island structure of many governmental and large organisations is a good example this phenomenon. In the area of information processing, the Greek gave us the ability to simplify by developing classification theory. This is clarified within the next paragraph.

3.1.3 Classification

Philosophers like Plato and Aristotle defined classification as the sorting of similar objects into groups, providing the ability to simplify and comprehend. It is the theory of putting the bathtub in the same room as the shower and the sink in the same room as the stove. Classification provides a set of standards to assist in communication and simplification [COOK96]. Figure 3-1 shows the relationship between architecture, a framework, and the method of classification. Architecture can be seen as the goal that has to be accomplished, a framework can be used as a tool to help accomplish this goal, classification theory can be seen as the theoretical foundation.

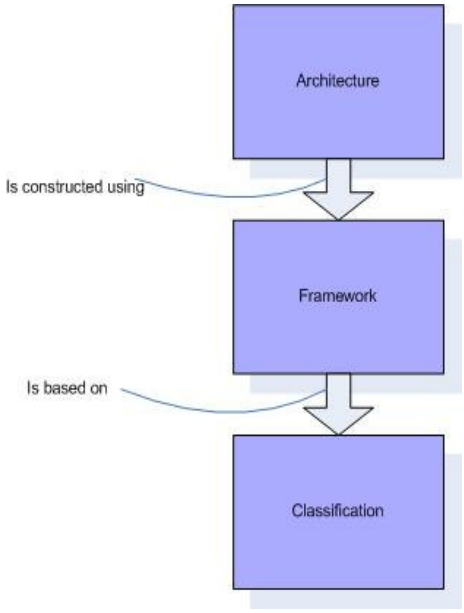


Figure 3-1 - Architecture as a goal, framework as a tool and classification as a method

3.1.4 Communication and awareness

Frameworks for enterprise architecture are extremely valuable for the communication process. While defining an architecture it is important to get everyone aligned, from the management and architects to engineers.

A framework provides a means for creating overview, observing relationships, and classifying objects. This encourages a structured approach to the development of an architecture. While creating an architecture it is important that everyone involved in this process thinks at the same level of abstraction.

3.2 Dimensions in an architecture framework

This paragraph discusses the dimensions that are frequently used in architecture frameworks. Each dimension will briefly be described.

In the past 10 years, many frameworks have been introduced. Some frameworks act as an instrument for enterprise architecture trying to embody the entire organisation; others are focused on the architecture of applications.

In the table below, the dimensions are described which are most frequently used in the classification of architecture frameworks [GREEF03]

Dimension	Description	Values
Area of application/Type of information	Subjects of the framework	Business, organisation, information, applications and technical infrastructure.
Scope	Areas on which the architecture is applicable to	Branch of industry, organisation, business unit, system family, system and component
Stakeholders	Aimed target group of the viewpoint	Customer, user, architect, annalist, developer
Transformation	Different transition phases	Current situation, short term, middle term, long term
Quality attributes	The (implicit) used quality attributes These characteristics find their origin in software quality but can also be applied to other types of information.	Functionality, reliability, usability, efficiency, maintainability, portability.
Kind	The kind of information in viewpoint	Policy, principle, standard, description, rule, guideline

Table 3-1 - The most common dimensions used in architecture frameworks

3.3 Framework for the adaptive enterprise principles

This paragraph will be used to describe the framework used for the positioning of the adaptive enterprise principles. First, an overview is given of the meaning and application of principles.

3.3.1 Principles, the content of the framework

Before describing the dimensions, the definition of digital architecture is required. Knowing what actually is positioned throughout the axes of a framework contributes to the reasoning process.

In the physical world, architects are concerned with the design of solid, functional buildings in which people enjoy living or working. Two major concepts can be recognised here; 1 Architects make a design; 2 the purpose of this design serves three goals: *functionality, a good construction and a pleasant and enjoyable workspace.* For the completeness and comprehension of this chapter, the definition of digital architecture is given one more time:

> *Digital architecture is a coherent and consistent set of principles, particularized to concerns, rules, guidelines, and standards which describe how an enterprise, information services, applications and infrastructure are designed and is perceived in its usage. [RIJS04].*

This definition clearly states *what* digital architecture consists of, namely principles. Principles that are coherent and consistent with each other. They give direction in favour of essential management decisions. Principles need to be concretised by defining *guidelines*, things that should be done, *rules*, things that must be done and *standards*, which are needed for the communication with the rest of the ecosystem.

The definition also states to *which* areas architecture can be applied. Business, information, applications, and infrastructure. These areas are described in the next paragraph.

Criteria for principles
Principles originate from a *strategy* or *mission statement* of an enterprise. They should be holistic and noticeable in every part of the organisation. These two reasons are exactly why they are extremely suitable for defining the characteristics of an adaptive enterprise. The desire to become an adaptive enterprise originates from a strategy or competence strategy, thus created in the boardroom.

Other characteristics and criteria of governing principles point out the applicability of principles for an adaptive enterprise [RIJS02]:

- They should be a fundamental idea, to meet a common requirement;
- They should originate either from ecosystem factors or from the enterprise themselves, these can be:
  - Government regulation;
  - Social trends;
  - Industry conditions;
  - Industry evolutions;
- Principles from the enterprise itself:
  - The own mission statement;
  - The vision;
  - Chosen strategy.
- They should establish boundaries for permissible behaviour, governing (not dictating) decisions, activities, and accountabilities;
- They are unambiguous and can therefore be formulated in statements beginning “we will never” or “we will always”;
- They should be qualitative rather then quantitative;
- They should be holistic by nature;
- They should last for at least a few years.

According to [APPEL-I], a description of a principle should certainly contain the following three attributes:

- Justification of the principle;
- Implication of the principle;
- Description of what happens if the principle fails.

In the description of the architectural principles in the next chapter, these directives will be used.

3.3.2 Three axes, giving content a direction

The dimensions in which an architecture is described according to [RIJS04] are: area of application, the scope of the architecture principles and quality attributes to which a principle gives direction. These three axes would result in the framework in the figure below.

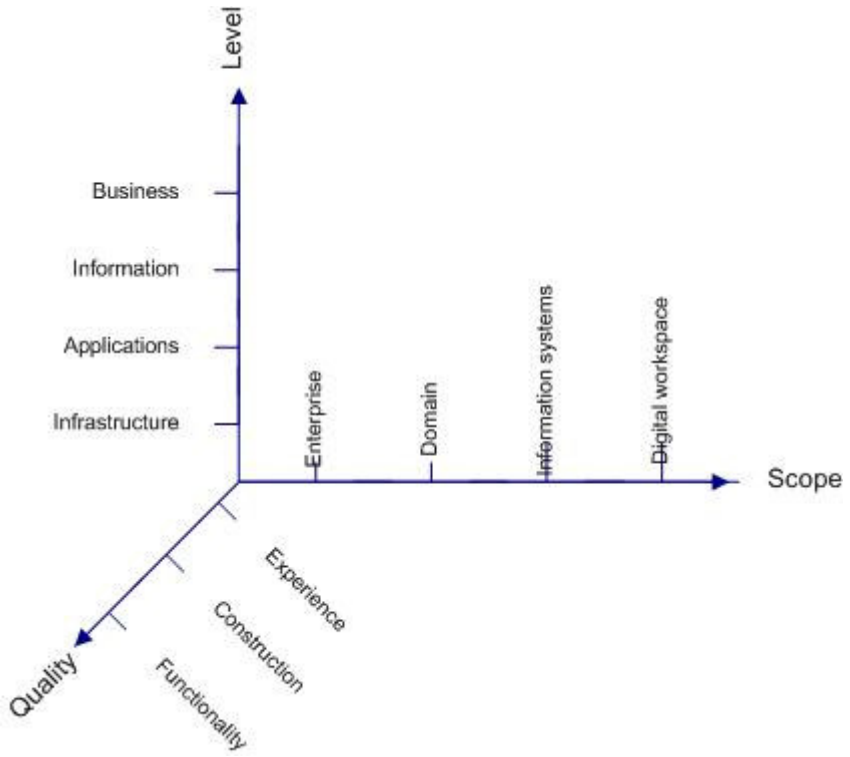


Figure 3-2 - Visualisation of the framework

However, throughout the completion of the research project it became clear that the principles of an adaptive enterprise could not be matched appropriately to the axis of *scope.* They are not suitable for the subdivision according to this scale. That is why there is chosen to replace this axis by one that was more appropriate. The scale that is introduced is one with the elements: *strategic, tactical* and *operational.* Each principle of an adaptive enterprise can be any of these three things by nature. This axis is called the *nature* axis. The description of the *scope* axis contains a validation why this axis is not appropriate for this research. The description of the *nature* axis can be found at the end of this paragraph.

Area of application

Within the area of digital architecture, four areas of application can be distinguished: business, information, applications, and infrastructure.

These areas cannot be seen independent from each other. Top down, these areas prescribe each other and bottom up they enable each other. Each area will shortly be described.

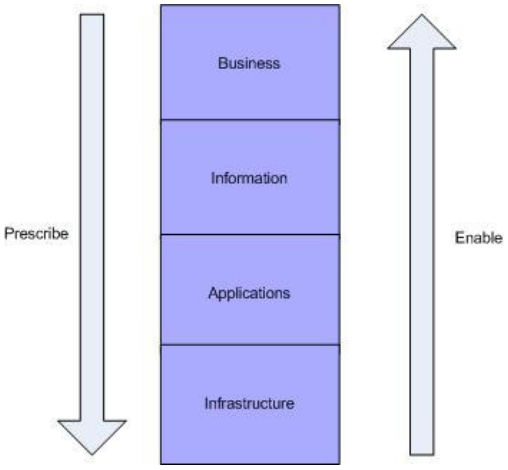


Figure 3-3 - Areas of application

Business

The business layer is the layer in which things like mission and strategy are positioned. In addition, the processes that take care of making profit are situated here, business processes to run day-to-day functions.

Business processes continuously and collectively set and adjust the level of the underlying layers to meet changing demands. The business determines which information needs to be inquired, moved, or transacted.

Information
Everything that has to do with information is situated within this level. Things that can be distinguished here are information streams, information needs, information sources, and information exchange with the outside world. The information layer is often tightly integrated with the business layer because the information layer specifies the things that business layer communicates about.

Applications
Applications acquire, organise, and transform the information needed to support the business processes. Enterprise applications like SAP deliver information throughout the entire organisation, making use of the underlying infrastructure. The information systems clearly have an enabling role towards the upper two layers. If an application fails to function, information cannot be processed and business decisions cannot be made.

Infrastructure
The infrastructure is the medium that binds all applications. This can either be hardware infrastructure or software infrastructure (middleware). Infrastructure services deliver secure, continuous storage and computing power required for the information systems to function properly. This layer functions as a foundation for the architecture contemplation.

In many models or architecture frameworks, you can recognise these architecture levels. This classification provides an enterprise with the ability to identify processes, people, and IT and subsequently to group them into these layers.

Scope
Like in the physical world, architecture in the IT world is also divided into several abstraction layers. This is done to make things more ordered. In the physical world, cities, suburbs, districts, and buildings can be identified. All these things are designed and architected individually. A town planner does not need to worry about the size of the windows of each individual home. The abstraction layers that can be identified in the digital world in order to reduce complexity are:

- enterprise layer;
- domain layer;
- information system layer;
- digital workspace

Each abstraction layer will be briefly described.

Enterprise architecture
At the enterprise level, a high-level architecture design of the entire enterprise is presented. This is done with the purpose to identify the domains, which consist of business processes, information streams, applications, and the underlying infrastructure. Enterprise architecture can be constructed with several intensions, like a helicopter view for the top management, control of complexity and tool for communication. This helicopter view is being used to identify several domains like marketing & sales, delivery or manufacturing together with its interrelations. Supportive domains can be embodied

by HRM, administration and finance. The enterprise architecture is all about bringing these domains and their interdependencies to the surface.

Domain architecture
The layer of the domain architecture is used to position all operational principles. It must be evident of what principles are applied, which business processes can be identified, how the technology is integrated and how customers are connected to these systems. Most of the transformations in an enterprise occur within this domain.

Information system architecture
On the lowest level within an organisation, the architecture of information systems can be identified. It contains all principles, rules and guidelines, which are needed for the decision making process for the construction and usage of information systems.

Digital workspace
Sometimes, an additional level is added to the range. This is the level of the digital workspace. A workspace in which digital services and information are integrated in one place. This is often accomplished via portal technologies. Compared to physical architecture, this can be seen as the design of the interior. The digital workspace can offer much more possibilities; it can connect to various domains at the same time. At this level, it is the challenge to create the space in which a user can satisfy his needs [OVER05]. Later, it will become clear that the digital workspace is of great importance for an adaptive enterprise.

Why this axis is not suitable for principles of an adaptive enterprise
This axis makes a subdivision in architectures, architecture on enterprise level, domain level, information system level, and digital workspace level. This is done with the aim to reduce complexity on the highest level. On the highest level, an enterprise does not want to worry about the smallest connections in an information system. While creating an architecture it is extremely important to bear this subdivision in mind. However, in describing the principles for an adaptive enterprise this subdivision is not appropriate enough. No principles or characteristics have been found that apply just for the domain level or for the information system level. The goal of this research is not to define an architecture for an adaptive enterprise, but to define principles from an architecture point-of-view. To simplify, order and abstract is not the goal here

Quality attributes
Creating or defining an architecture has everything to do with quality. Each principle or requirement aiming at covering some area within an enterprise has a quality implication. Consider for example the requirement that information system ‘A’ must be available every weekday from 9.00 to 18.00. This is a quality requirement, which can be positioned under the category of *availability*. Another requirement may be that a specific function within an application may only be available for people who are entitled to use it. This is a requirement that can be positioned under *security*.

As within physical architecture, the quality attributes can be reduced to three main areas that have their origin in ancient Greek architecture thinking [RIJS02]:

- Functionality;
- Construction;
- Experience;

You can recognise these aspects in every historical or modern building. All three need to be in tune to be able to give a building a soul. You want a building to look and feel pleasant. You would not want to work in building which is not challenging you to do so (*experience)*. A building must also be accommodated within the function that it has. For example, a high school must have sufficient classrooms in order to create a decent environment for educational activities (*functionality)*. Finally, a building must also comply with the needs for decent construction. What kind of materials are used for the construction of a building? In addition, the aspect of maintainability is important within this view. It is not desirable to construct a building that does not facilitate maintenance (*construction).*

Translated to IT architecture, these areas can be identified as:

- The functionality of each component and their structural relationship.
- The construction of each object. What are the reasons for choosing a certain construction method or technique?
- The appearance of the object. This is essential for the pleasance of use. When talking about information systems, the user interface must be enjoyable to work with. In architecture descriptions this viewpoint is often omitted, form and function are frequently emphasised. IT is becoming more and more important in our daily lives. Therefore the need for user friendly and enjoyable information systems is therefore high.

As within physical architecture, these areas cannot be seen independently of each other. Changes in one area will have implications in the other. It is the challenge of the architect to find the perfect balance between these areas of interest.

Nature

The nature of a principle appeared to be more appropriate to be taken into account in describing adaptiveness than the scope on which architecture can be seen. Some principles focussed more on awareness whereas others more focussed on the execution of an activity. Therefore the following subdivision of principles is introduced: strategic, tactical, and operational. Each one of these will be shortly clarified.

Strategic

As the name implies, strategic principles should be present within the strategy of an enterprise. They should set the direction for other principles or activities at lower levels. They are usually not active by nature but focus more on awareness, or define boundaries for the completion of certain activities. A strategy is a long-term plan to achieve some kind of goal. Principles within this strategy should facilitate the awareness and eventual achievement the goal. This is done to set directions for the lower tactical level at which is determined which activities can be best carried out to accomplish that goal.

Tactical
Tactics are often confused with strategy. Tactics are the actual means used to gain a goal, strategy is the overall plan. Tactical principles for an adaptive enterprise give direction and design for the execution of operational tasks that have to be taken to accomplish a goal. Furthermore they give direction to the real actions that have to be carried out in order to accomplish the task.

At this level, some key performance indicators can be defined for the measurement of several operational tasks or principles. This can be done to constantly asses and verify that the defined goals and chosen strategy are being accomplished.

Operational
Operational principles primarily concentrate on giving direction for the completion of some kind of task. They can result from principles on the tactical and strategic level.

In [HPDW-02], the following example was given to emphasise the relationship between strategic, tactical and operational.

Figure 3-4 - The relationship between operational, tactical and strategic

3.4 Conclusion

The framework described in this chapter is used to position the architecture principles that have been acquired during the research project. The method of classification is used to group objects that have similar characteristics. This facilitates the simplification process and makes it possible to reason and communicate about them. These are the main principles for using a framework as a tool for defining an architecture. A framework also helps in the process of checking that an architecture is complete. Areas that not have been covered can be identified quickly.

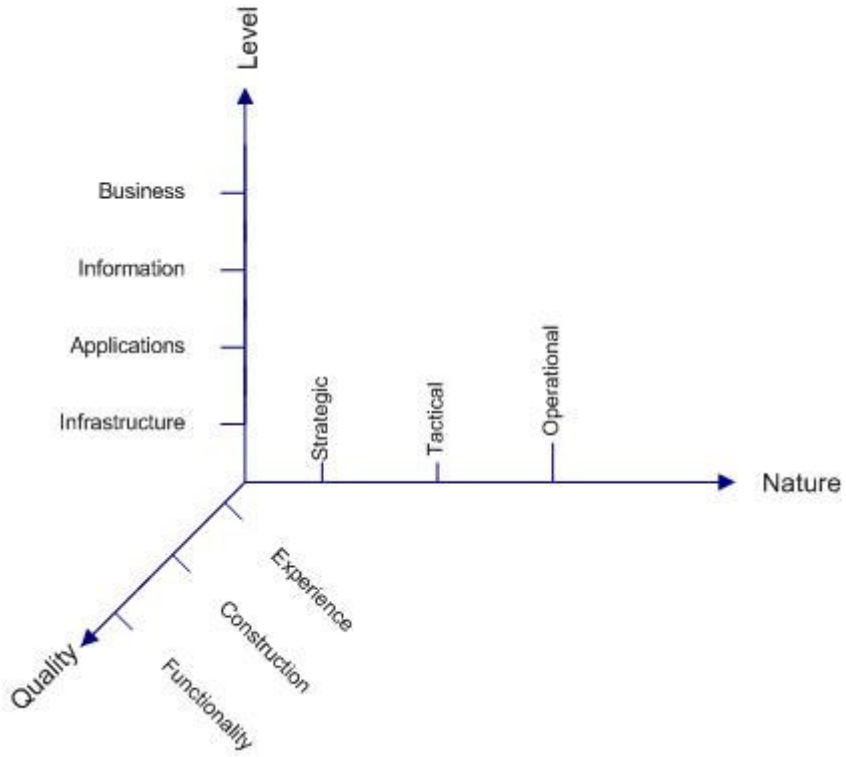


Figure 3-5 - 3D framework used for this research

The dimensions that are used within the framework proposed for this research (figure 3-5) are a*rea of application, quality attributes* and *nature.* The area of application specifies the horizontal level of application within the enterprise. Principles can be defined on a business level and have effect on the levels below, but they can also be defined on the level of applications or infrastructure. It is important to underline the interdependency between those layers, top-down they prescribe each other and bottom-up they enable each other. Digital architecture as well as physical architecture aims to meet several quality goals. These goals facilitate the creation of an enjoyable environment to work in (experience), the creation of a functional environment (structure/functionality) and the creation of a solid, maintainable and extendible environment (construction). It is the art of the architect to find the perfect harmony between these characteristics in order to create a desired architecture. Finally, the nature of a principle can either be strategic, tactical, or operational. On a strategic level they give directions or define boundaries for the possible success of the strategy. On a tactical level they give directions for the activities and initiatives that have to be carried out in order to achieve a successful completion of the strategy. At an operational level, they give direction to the individual tasks.

4 Principles for the adaptive enterprise

In this chapter, the research results of the first part of the research project are presented. This is the result of the answer to the first sub question. Questions that will be answered within this chapter are:

- What are the known definitions of an adaptive enterprise? (paragraph 4.1)
- How is the definition of an adaptive enterprise constructed for this thesis? (paragraph 4.1)
- What are the main principles of an adaptive enterprise according to the IT service providers? (paragraph 4.2)
- To which area of application, quality attribute, or nature do the principles belong? (paragraph 4.3)

4.1 The adaptive enterprise defined

Chapter two focused extensively on the need for an adaptive enterprise. An enterprise that is able to react quickly to changes in the ecosystem. In today's market, there are several perceptions of what an adaptive enterprise really is, what it consists of, and what it does.

The definitions the service providers keep will now be analysed after which a personal definition of an adaptive enterprise is given. Note that the goal is not to criticise these definitions, but to analyse them in order to construct an even more powerful definition appropriate for this research.

4.1.1 Definitions according to service providers

Definition of Capgemini
'An adaptive enterprise is an organisation, which permanently leverages its internal processes to take advantage faster than the market of unpredicted events.'

Definition of IBM
'An adaptive enterprise is an organisation whose business processes – integrated end-to-end across the company and with key partners, suppliers, and customers – can respond with speed to any customer demand, market opportunity, or external threat.'

Definition of HP
'An adaptive enterprise is an organisation that is able to deploy services faster, create new revenue streams more quickly, and respond to customer requirements in a dynamic, brutally competitive market environment, in order to maintain competitive advantage by synchronising business and IT to capitalise on change.'

Definition of Metagroup
'An adaptive organisation is one that focuses on dramatically improving the economics of business change to enhance organisation's performance (e.g. profitability, growth, liquidity, integrity). This is accomplished by harnessing IT to automate new forms of collaboration, innovation, resource sharing, and sourcing to dynamically optimise loosely coupled modular resources (e.g. people, products, services, technologies, processes) in a timely fashion, to a constantly changing competitive market'.

In these definitions, several concepts can be recognised. These concepts can be divided into the following categories.

*What an adaptive enterprise **does**:*

- focus on improving the economics of business change;
- responding with speed to customer demands, market opportunities or external threats;
- obtaining competitive advantage;
- being faster then the market / competition;
- capitalising on change;
- enhance performance;

*What an adaptive enterprise **possesses**:*

- end-to-end integrated business processes across the company and with suppliers, customers and partners;
- ability to deploy services faster;
- ability to create new revenue streams;
- ability to respond with speed to customer demand.

*Why adaptive capability is **needed***

- because unpredicted events occur;
- to react faster and better than the competition does in a dynamic competitive market;

*What an enterprise **must do to become adaptive***

- harnessing IT to automate new forms of collaboration, innovation, resource sharing and sourcing;
- leveraging its internal operations;
- synchronising business and IT;

What an enterprise does and *what an enterprise possesses* are attributes of the enterprise itself. A definition of an adaptive enterprise will not be enriched by the reasons for adaptivity or the actions that must be taken in order to become adaptive.

In the commonality between what an adaptive enterprise does and what an adaptive enterprise possesses, the following two things can be distinguished:

- An adaptive enterprise is constantly improving its internal operation, in order to be faster in response to changes than competitors.
- An adaptive enterprise is capable of quickly finding new ways to create value.

4.1.2 Construction of a definition

The characteristics of a definition that is formulated for this thesis are the following:

- The definition describes characteristics of an element of the entire collection of adaptive enterprises. These can either be actions, things that these kind of enterprises do, or things they posses;
- The definition should not be vague or ambiguous. All concepts within the definition should be clarified;
- It states nothing about how an enterprise should become adaptive or the reasons why it should be adaptive.

According to these properties the following definition can be constructed:

An adaptive enterprise is one that can determinately react with speed, ease, and effectiveness to relevant changes within the ecosystem it resides in

The reaction must be determined, being executed with awareness and following from principles that have their origin in business strategy. The reaction must be quick, in order to be ahead of competitors or other factors that require speed. For example, an internal revenue service (tax office) does not have to be adaptive to competitors, because they have none. However, it is extremely important for them to be flexible to changing legislation and other governmental decisions.
The reaction must be performed with ease, not taking too much effort.

Speed and ease are often regarded as *agility.* The enterprise' reaction has to be effective, which means that the reaction should last for a reasonable amount of time and the reaction should be sustainable and of value for the future of the enterprise. The enterprise should have learned from its reaction in order to improve its behaviour in similar situations.

For the scope of this research, it is interesting to see how an enterprise accomplishes this agile and effective behaviour. That is why this definition is extended.

An adaptive enterprise accomplishes this behaviour by creating adaptive capability and combining this capability with a strong notion of where to apply this capability. Adaptive capabilities can be accomplished by creating and applying one or a combination of the principles mentioned below.

These principles have been compiled from literature and several interviews that have been conducted with representatives of the IT service providers.

- be innovative;
- be aware of the meaning of the adaptive concept;
- recognising IT as an enabler of adaptive capability;
- holistic thinking;
- internal value recognition;
- external value recognition;
- maximisation of modularisation;
- be variable;
- maximisation of simplification;
- maximisation of integration;
- maximisation of virtualisation;
- maximisation of standardisation;
- be as reactive as possible;
- close feedback loops;
- improve employee circumstances.

These principles are extensively discussed in the next paragraphs. As the main goal of the research project was to define principles for an adaptive enterprise, the actual characteristics of an adaptive enterprise are used to build up those same principles. Everything a principle can be constructed of (guideline, rule or standard) will in the end result in a characteristic of the entire enterprise.

4.2 Overall principles

4.2.1 Overview

In this paragraph, all distinct principles and characteristics of an adaptive enterprise are described. The requirements for the description of principles resulting from chapter three will be used in the description of the principles. These are:

- What role does this principle play for the AE?
- What is the value derived from this principle?
- What happens if the principle fails?
- What are the rules and guidelines that concretise this principle?
- What are the business layers in which the principle is represented?
- What are the quality attributes the principle can relate to?
- What is the nature of the principle?
- What is the relationship with other characteristics of an AE?

All these principles below result from extensive literature research and several interviews. The formulation of the principles and the choice for certain rules and guidelines results from an extensive analysis and interpretation process.

4.2.2 Be innovative

Innovation is the key to being ahead of your competitors and differentiate from them. This is explained by the following definition.

Innovation is the introduction of a new idea into the marketplace in the form of a new product or service, or an improvement in organization or process.[ZIS04]

An essential element of innovation is its application in a commercially successful way. This can be done by creating new products and services that appropriately fit customer needs. Innovation can also show an improvement in internal operational processes. Anything that results in a step forward in the organisation, a leveraging action, can be seen as an innovation.

Note that stopping new initiatives because they do not comply with predefined goals is also innovation. It is the improvement of an organisation or process.

If an enterprise does not innovate by creating new products or improving its operational excellence, it will gradually get behind on the competition. There will always be a competitor that introduces a new product or optimises its processes in order to get

ahead of the competition. Eventually not innovating will have a negative effect on the enterprise.

To empower this principle some rules and guidelines are given.

Rules:

- An enterprise must constantly be aware of the possibilities it has of (re)combining existing components.
- An enterprise must be aware of shortcomings in the current product base of the enterprise itself and competitors. Only then, it can innovate with new products that will be effective. This awareness can be created by creating an emotional relationship with customers.
- An enterprise must constantly track the progress of new initiatives and be able to stop them if they do not comply with predefined goals.

Guidelines:

- An enterprise should be open to change, so it can easily start new initiatives to react to this change;
- An enterprise should regard failures on macro and on micro level as investments. It should learn from these failures, leading to small but effective innovation;
- Innovators should think outside the box. They should not conclude from experiences or what is possible. They should think of what they *want* and what the *goal* is. From there on the search begins for a solution.

Innovation is all about awareness, being able to know what is going on and how an enterprise is going to anticipate to changes. That is why the principle of innovation is mainly situated within the *business layer.* Nevertheless, the result of an innovation can have its effect on all layers within an enterprise. Think about the introduction of new processes, recombining new processes, or the introduction of new solutions for information exchange, storage and presentation.

Quality attributes:
The definition of innovation states that it can have an internal and external component. An internal component that focuses on innovations to improve operational excellence. An external component that focuses on the introduction of new services or products to customers.

For the internal component, the quality attributes can be identified as *construction* and *functionality*. It is about an improvement of the way the enterprise or business layer is constructed. By innovation, new functionality is added to the business layers or other artefacts. That is why *functionality* is also an important quality factor.

For the external component, *functionality* is the most important characteristic, it is about an improvement in the way a customer uses the functionality an enterprise has to offer. The introduction of a new product for example, leads to the addition of new functionality an enterprise can supply.

Nature of principle
An enterprise must see itself as innovator and turn all levers in the right direction to facilitate innovation. That is why this principle has mainly a strategic character. The

awareness of being an innovator will eventually result in initiatives for the actual completion of this principle.

Relationship with other principles
It is important to have a notion of *where* and *when* innovation is required. That is why this principle is closely related to the *internal and external value recognition* principle. The relationship can be seen on a *rule* level, it must be there. An enterprise needs to know where opportunities are, and thus where value can be created. With the notion that termination of initiatives is also innovation – it is the improvement of an internal operation - this principle can be related to the *close feedback loop* principle.

4.2.3 Be aware of the meaning of the adaptive concept

Fully adaptive enterprises do not yet exist [FER03]. It is a continuous journey of adding adaptive capability and gradually becoming more adaptive. First, adaptive components or Lines of Business have to be created that eventually interconnect and give the entire enterprise its adaptive capability. In some cases, it might be sufficient that only some parts of an enterprise become adaptive, it depends on the places where pain is mostly felt and thus value can be created. It is crucial for enterprises to understand this. Adaptivity cannot be bought. Therefore, it is important for enterprises to be aware of what adaptivity means. *Awareness* of the meaning of the adaptive concept is important for possible success of the strategy it is embedded in.

Even, if an enterprise is not aware of the adaptive concept, it may still become (partially) adaptive. However, this result will only be accidental and not based on planned changes or common understanding. Success is therefore not guaranteed.

This awareness principle can be seen as a design principle that should be present within every business initiative that occurs in the enterprise.

The following rules and guidelines give an impression of how awareness of the adaptive concept can be accomplished.

Figure 4-1 - The business layer within an enterprise must have a certain amount of awareness

Rules:

- The adaptive enterprise roadmap (**what** do we want, **when** do we want it, and **how** do we want it) must play an important role within the enterprise' strategy, guaranteeing its existence within the enterprise for a long period of time (5 to 10 years).
- The strategy in which the adaptive enterprise concept is integrated must be understood and accepted by everyone in the boardroom. This understanding is extremely important; because it also prevents enterprises from thinking that they are already adaptive, while they are actually not.

Guidelines:

- An enterprise should recognise that adaptive capability cannot be achieved over night. It is a journey that should be well designed. Opportunities should be created for quick wins, in order to achieve acceptance of the strategy. After which it should also guarantee long-term improvement.
- An enterprise should implement an enterprise architecture that facilitates the migration to an adaptive enterprise. The importance of this guideline is mainly found in the awareness of the journey and the future state of the enterprise. This contributes to the acceptance of the strategy.

Because this principle has its origin in awareness, it can be seen as a strategic principle. If this principle is not present, success of the strategy cannot be guaranteed.

The quality attribute related to this principle can be identified as the *functionality* attribute. The notion of being aware of the adaptive concept is equal to the notion of which *function* the adaptive enterprise concept is going to play within the enterprise.

4.2.4 Recognising IT as enabler of adaptive capability

Management must be aware of the fact that IT and technology can deliver most of the capabilities and underlying structure of an adaptive enterprise. Technology is a catalyst for adaptivity as well as a source of inspiration. Technology is mentioned separately from IT, because it is not only IT that facilitates adaptive capability. Technologies like VoIP, telephony and digital media remain and become more important for today's' business. According to [TOL-I], it is important to see technology as enabler and get inspired by its promises, however it should not be leading within an enterprise. An enterprise should have control over the technology, not the technology over the enterprise.

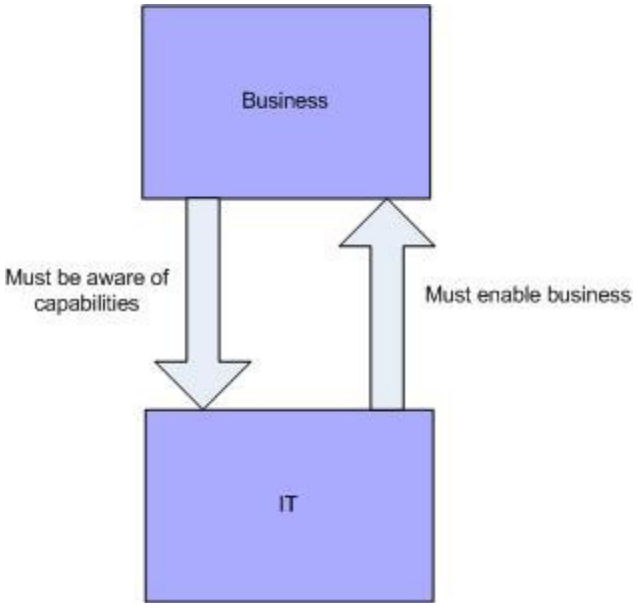


Figure 4-2 - Relationship between business and IT

It is because of IT and technological innovations that companies are now able to perform e-business and customers are able to buy their products online. It would be unwise to disregard these technologies on the road to an adaptive enterprise.

Creating this awareness can partially be accomplished by letting the person responsible for IT and technology (CTO and CIO) have a seat in the boardroom. The following rules and guidelines have been set up to clarify this principle.

Rules:

- An enterprise must be aware of the capabilities and advantages IT can offer.

- An enterprise must have feeling with the market and be aware of innovations that can be used.

Guidelines:

- The CIO/CTO should have a seat in the boardroom.
- The CIO/CTO must sense the market for rising technologies that could enable or facilitate the adaptive concept.

This principle is also about awareness. Awareness that should be present within the boardroom of an enterprise, and therefore resides within the business and strategy layer. Awareness of the functionality IT and technology can offer, the quality attribute of *functionality* is therefore of most importance for this principle.

4.2.5 Holistic thinking

It is important to see the enterprise as an entire system. A system with all its properties, assets, processes and structures. The overall sum of these things can be greater than a simple totalling of the individual parts, because the system as a whole adds something. An enterprise should have the intelligence to see what is going on within the entire enterprise. Enterprise architecture is a useful tool for creating this holistic view. Enterprise architecture facilitates the identification of areas where adaptivity is needed.

If an enterprise is not capable of holistic thinking, it is not capable of applying adaptive capability, because it does not know where to apply it. Success is only accidental in that case.

Rules:

- An enterprise must construct an enterprise architecture that gives overview of the entire enterprise.
- At the same time, this enterprise architecture must give directions for the migration path. How, where and when actions need to be taken to come to a future state.

Guidelines:

- An enterprise should have the intelligence to see what is going on within the enterprise as well as outside the enterprise.

Holistic thinking is also a principle that has its nature within awareness. Therefore, it also resides within the business and strategy layer. An enterprise must be aware of the fact that only with a good overview of the enterprise, it can determine where adaptivity is required. There is also a tactical component within this principle. The creation of an enterprise architecture is crucial within the business, as it facilitates the execution of many other tasks and principles, like:

- Knowing where adaptivity is needed;
- Knowing where there are flaws in the creation of value;
- Knowing how to modularise certain parts of the enterprise;
- Knowing where innovation is needed to optimise certain business processes.

The *construction* and *functionality* quality attributes play an important role within this principle. Architecture is about the construction of an enterprise and the functionality it can deliver to its ecosystem.

4.2.6 Internal value recognition

An enterprise should be able to leverage the things it does best and it should stop initiatives that do not drive value. The name *internal value recognition* also implies the recognition of the lack of value. It is as equally important.

The value of the principle lays in the awareness of the entire enterprise and the value each business unit or business initiative can add. If an enterprise lacks this recognition, it can not adjust its business processes properly to changes and events within the ecosystem.

The following rules and guidelines can be distinguished for this principle.

Rules:

- An enterprise must be aware of the competencies it has internally. Which department can deliver which service?
- An enterprise must be aware of places where there is a lack of value.
- An enterprise must apply holistic thinking, in the form of enterprise architecture.
- An enterprise must apply close feedback loops to maintain this recognition.

Guidelines:

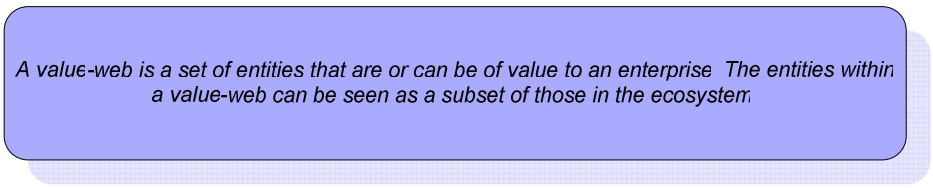
- An enterprise should be aware of the load of the internal services and resources.
- An enterprise should show entrepreneurship. Not being afraid of initiating and cancelling new initiatives.

This principle should also be present within the strategy of an enterprise. Without being aware of internal capabilities it is hard to optimise and adjust the internal functioning to changes from outside.

This principle is very closely related to the *close feedback loops* principle, because that principle allows to track and trace initiatives and artefacts within the entire enterprise. This eventually facilitates appropriate governance.

4.2.7 External value recognition

An enterprise must see itself as part of a larger value-web. A personal definition for value-web is introduced.



An enterprise should be aware of its core competencies and know those of others. Only those things should be done of which an enterprise knows it is good at. Non core-business activities could for example be outsourced to other enterprises within the value-web.

It is important to recognise the role of the enterprise within the value-web. To illustrate this, some real-life examples are given of enterprises that did recognise themselves as part of a larger value-web.

Collaborations arise that would have been rare in the past, that reach out to new customers with new products. Think about the collaboration between Heineken (brewery) and Krups (manufacturer of household electronics), delivering a home beer tap, which takes away the clientele of traditional bars![LIJ02]

The introduction of the On-Star system by General Motors is another example. Through the convergence of wireless technologies, global positioning systems and in-vehicle electronics provides drivers with customised information and services through the use of wireless voice and data communication systems. By combining several products and services into one, completely new product/market combinations can arise, which in this case, distinguish General Motors from other car manufacturers.

The companies in these examples have one thing in common; they are extremely aware of the value-web they reside in and know how to anticipate to, in order to differentiate themselves from others. Collaborating with other markets or introducing new products are just two examples.

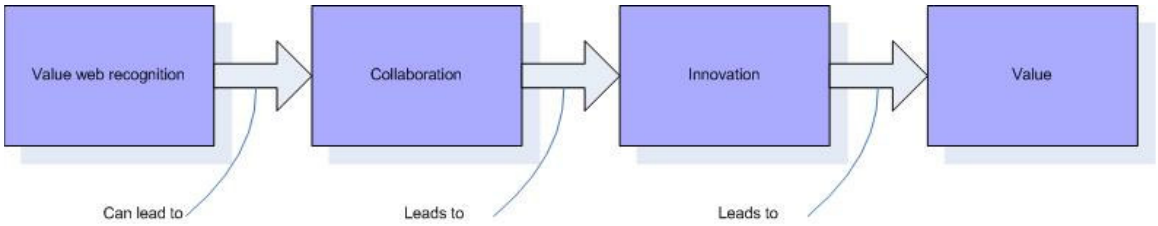


Figure 4-3 - Creating value by having value web recognition

Another result of sufficient value-web recognition might be the outsourcing of for example the call centre department of an enterprise. Just for the simple reason that another enterprise might perform this activity much cheaper.

If an enterprise lacks this recognition it operates from an island, not knowing what is going on and not knowing where value can be created or costs can be reduced.

The following rules and guidelines can be distinguished for this principle.

Rules:

- An enterprise must be aware of its core competencies and those of others.
- An enterprise must fully exploit collaborative opportunities. It should have the notion of collaborating with other enterprises to achieve certain goals.

Guidelines:

- An enterprise should judge its own competencies and those of others and envision what opportunities may arise by combining those competencies.
- An enterprise should have the intelligence to see what is going on within the enterprise as well as outside the enterprise.

Awareness plays again an important role within this principle. It is not about taking action like sensing the market and recognising changes (sense and respond), but about the awareness of the role the enterprise can play within the entire ecosystem. This principle must therefore be present within the business and strategy layer of an enterprise.

Combining and recognising *functionality* is the essential activity within this principle, therefore functionality is the most important quality attribute.

4.2.8 Maximisation of modularisation

An enterprise should break down the enterprise layers that require adaptive capability, into manageable components. Components can be of any kind, web services, storage components, servers, or individual applications. This process of breaking down into components can be done for every level within an enterprise. It is important to recognise the importance of being aware of the size components; too small components trigger great challenges at the management level. Large components however will become unmanageable themselves.

It is important to recognise that modularisation should only be applied to those areas that require adaptive capability most. According to [GREEF-I], an enterprise should only break up a component, when the two remaining components have a function on their own. Only then it is worthwhile to modularise. Breaking up every layer within an enterprise is probably too expensive in resources and time.

With modularity, storage and computing power can be dynamically scaled and redeployed to meet upward or downward processing requirements of individual applications. Another advantage is that a component or module can be modified without changing the others. This contributes to the maintainability of the entire system.

Using this modular approach, IT functions can be outsourced or grouped much easily, such as call centres or billing activities. This also clarifies the value of modularity; it enables flexibility. If an enterprise does not break up some structures internally, it will remain rigid and inflexible.

Although modularisation (with clean and simple interfaces) enables flexibility, it only does so when there is clear insight in the enterprise and places where modularisation can be of most importance. According to [AUT-1004] this can be a real danger regarding web-services. Web-services are cheap and flexible and can therefore easily be developed. However, if this is done not carefully it can trigger rigid and unmanageable units of tight systems. Systems which themselves become inflexible and insufficient. A non-architectural approach to web-services (re)introduces the problems that these middleware solutions are actually trying to solve.

Rules

- Levels that require adaptive capability must be broken down into manageable components.
- Holistic thinking must be applied in order to know *what* has to be broken up, and what the *effect* is.
- An enterprise must manage complexity in the process of modularisation, preventing it from becoming an unmanageable tiger. The number of connections will increase and therefore complexity.
- One of the ways to manage simplicity is to *standardise* on interfaces. Making uniform connections and interfaces contributes to an increase of manageability.

Guidelines:

- An enterprise should be aware of the size of its components. Too small components trigger too many management activities. Too large components become unmanageable.
- These modules should be loosely coupled contributing to the fact that they can be easily recombined, replaced or updated.

For this principle, several standards have emerged to facilitate it. This is because of the fact that modularity is concerned with the infrastructure and application layer within an enterprise. These are often the layers that are most rigid and inflexible. The solutions the industry offers therefore concentrate mostly on these areas.

Standards

- SOA. (Service Oriented Architecture) A system for linking services on demand. In a SOA, services are made available to other participants in the network independent of their implementation. This provides more flexible loose coupling of functionality than in traditional systems architectures.
- Grid. A type of distributed computing in which a wide-ranging network connects multiple computers, whose resources can then be shared by all end-users. Other forms of GRID computing can be storage like or computational like.
  Grid computing allows companies to deliver computing power where they need it, only when they need it; they pay for what they use, when they use it.

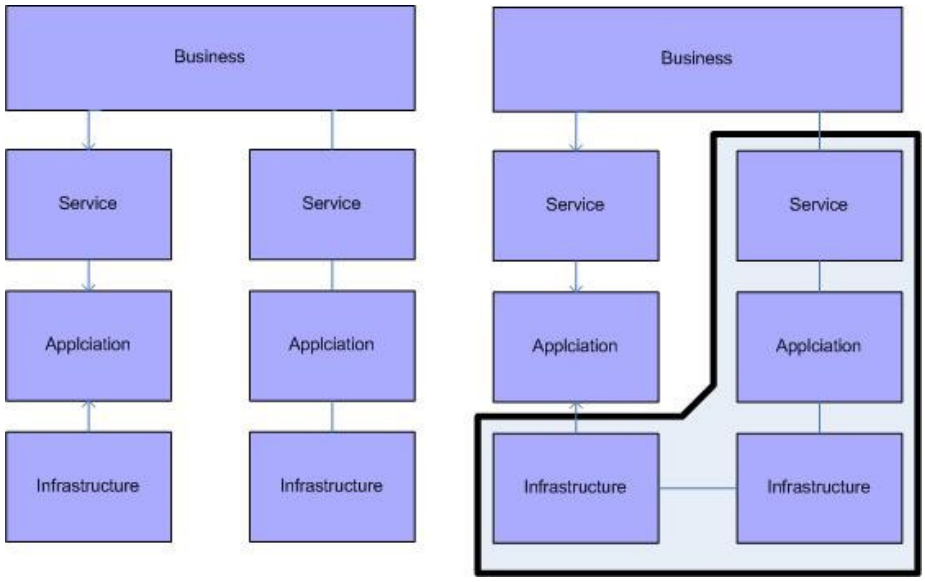


Figure 4-4 – Flexible replacement of infrastructure due to a modular approach. On the left you see applications that have a dedicated infrastructure and services that are supported by dedicated applications. On the right, it is also possible to add more infrastructural components for the operation of an application.

Modularisation is mainly concerned with the lowest levels within the enterprise. Having a modular infrastructure for example is a hot topic nowadays. Companies like Oracle, HP, and IBM pay a lot of attention to it. However, having modular capability throughout higher levels within the enterprise also facilitates a fast relocation of activities. If an

enterprise could *plug and* play a business process from one application area, to another application area, offers extreme flexibility. For example moving a supply chain process from one product to another without making too much of an effort. A television manufacturer could show extreme flexibility if it could use the same business processes for the production of LCD televisions as for the production of traditional televisions. Currently, modularisation is mainly found in the infrastructure and application layer.

This principle is primarily operational by nature. It is enabled by a more tactical principle like *being variable*. It is about the action of decomposing rigid structures into a more modular and flexible structure.

Quality attributes
Modularisation focuses on the construction of the enterprise. Within most enterprises, it is the decomposition of a rigid and cumbersome structure, to a modular structure. That is why the *construction* aspect is the most important for this principle.

Related to:
Modularisation is not something you implement overnight. It requires sufficient insight in the entire organisation, that is why this principle is closely related to the principle of *holistic thinking.* While constructing a modular enterprise it is extremely important to simplify, or at least manage complexity, as mentioned in the description of the *simplification* principle. This facilitates the ease in which a component can be replaced, eliminated, or used for other purposes. This is why the principle of *simplification* is also closely related to *modularisation*.

4.2.9 Be variable

An adaptive enterprise should be variable at every level of the enterprise, so every layer or component can adapt as quickly as possible to changing demands or threats. This also includes for example not having too many regulations that keep employees from being innovative.

The culture and mindset of the people working in an adaptive enterprise must be open to new ideas. The people themselves have to be adaptive in order to react on events [SCHEK01].

Another important facet of variability is the robustness of an enterprise or its parts. It should have a certain amount of variability so it can deal with unusual threats coming from customers, suppliers or competitors. Robustness could also be appropriate for other threats named in chapter two, like earthquakes, terrorist attacks or changing environmental conditions.

Rules and guidelines that empower this principle are:

Rules:

- An enterprise must not imply too many rules that prevent individuals from being innovative.

- An enterprise must be able to recombine or create components into a precise format needed to respond to current needs. This can be effectuated by the use of technologies like GRID computing or utility computing[9].

Guidelines:

- An enterprise should regard failures on macro and on micro level as investments. It should learn from these failures.
- An enterprise should adjust the cost of use of technology as demands dictates. This can be done by having budget portfolios instead of fixed budgets. This enables variability on the financial part.
- An enterprise should be able to assign resources to a different purpose if needed. Resources can be processing power, people or technologies).
- Technology should not be bound to its physical limits. Having not enough space for placing additional equipment should not be an excuse for not being variable.
- Each module/component (application, service, infrastructure component) should not be build for its peak usage. An enterprise should make use of load sharing. It is inflexible if an enterprise buys infrastructure just for its peak usage, if this peak usage only occurs sporadically.
- Protect systems from intrusions by applying monitoring and alert systems that allow automated self-protection.

As you can see throughout the description of guidelines, *variable* capability is needed through every layer of the enterprise. On a *business* level, one should not imply too many rules and on an infrastructural level, it is important to have scalable components.

Being variable is a real tactical principle. It gives directions for other small actions and initiatives on an operational level. It is too explicit to be a strategic principle.

The variability principle contributes to the quality characteristics of *construction* and *functionality.* By enabling a flexible structure in every layer of an enterprise, this structure can easily be reformed to fulfil another function. Not having too many rules within an enterprise contributes to an increase of functioning of employees as well as departments.

Variability is often replaced with terms like adaptive and flexible. Flexible and variable are interchangeable for this research. It is about having the capability of restructuring and reorganising internally according to some demand. Adaptive is more then being variable. It is about knowing how to use and apply this variability.

4.2.10 Maximisation of simplification

Chapter two illustrated the bottleneck which is created by a complex IT infrastructure, in order to react to changes. Therefore, the management and reduction of complexity is essential for an enterprise to be adaptive. The concept of simplification can be applied to many levels within the enterprise.

The value of this principle lies in the fact that simplified applications and systems are easier to adopt, use, connect and modify.

[9] utility computing delivers computing power to companies as they need it, and only for as long as they need it—making it as reliable, affordable and easy to use as common utilities.

It is important to mention that adaptive enterprises are not predominantly simple and do not contain complexity. It is more the other way around, as connectivity with the ecosystem grows and enterprises become virtual, complexity will grow exponentially [SCHEK01]. That is why the principle of *simplification* focuses on the management and overview over complexity, with the aim of reducing it. Behind extreme simplicity hides extreme complexity, a paradox [LIJ02].
Simplification can be accomplished by focussing on one or more of the following activities:

- Collocation[10]. This is about the consolidation in the housing of servers and other infrastructural assets. The advantages are a reduction of management costs, because you have fewer locations, as well as an increase in security, availability and system utilisation.
- Application or service integration. This is about eliminating redundancy. It makes a difference whether an enterprise encompasses 2000 or 500 applications in a migration project.
- While using (standard) components within a modular organisation, infrastructure or development environment, you can hide complexity of a component itself by just stating which services or functionality the component delivers. The components hide their internal logic, thus hide their complexity.
- Self-management. This mainly focuses on the level of applications and infrastructure. Self-managing systems manage their own complexity internally. An example: the engine of a car has an electronic engine management system that controls the combustion (the transformation of biomass fuel into heat) and the catalyst. Without this self management it is impossible to meet environmental requirements.

All these things facilitate change in the future. Simplification can also be seen as a design principle that should be present enterprise wide, and especially within migration projects.

Rules:

- The amount of applications must be reduced to a minimum.
- No enterprise is unique, therefore enterprises must make use of standard components (COTS – commercial of the shelf components) as much as possible. These standard components enable the reduction of complexity.

Guidelines:

- Widely distributed systems should be reduced into fewer, centralised locations.
- While performing integration at different levels throughout the enterprise and maybe throughout the ecosystem it is important to stick to industry standards.
- Supply a limited or defined amount of solutions for one known problem.

Regarding the quality attributes *functionality, construction*, and *experience,* the principle of simplification contributes to all of them. For example, a simple infrastructure contributes to more flexibility which in turn contributes to an infrastructure in which more functionality can be derived from just plug and play infrastructural components. A simplified construction facilitates changes to it in the future. The experience attribute

[10] Placement of equipment at common physical site to reduce environmental and financial impact and network deployment.

comes in when it comes to simplified front office applications and interfaces, which contribute to a more pleasant operating environment.

The principle of simplification can be seen as a tactical principle. It gives directions for the execution of operational principles like modularisation and integration.

4.2.11 Maximisation of integration

Integration is essential for the success of an adaptive enterprise. Through integration, it is possible that the sales department gets the same customer information as the support department. It informs manufacturing what R&D is doing long before a product hits the factory floor. It connects corporate planners to your distributors so they can figure out holiday season sales.
Several levels of integration can be recognised.

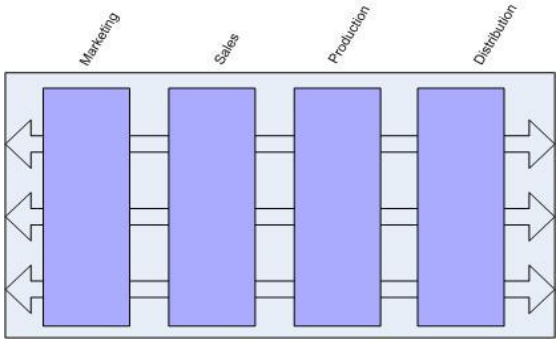


Figure 4-5 - Horizontal integration

Vertical integration
By connecting or merging applications and removing silos that impede the flow of information, performance of a department or line-of-business can increase (Figure 4-5).

Horizontal integration
Horizontal integration means that you have the ability to integrate processes across different lines of business, different types of functions such as development, marketing, sales. The great advantage is that information does not have to be stored multiple times and processes can increase in speed (Figure 4-6).

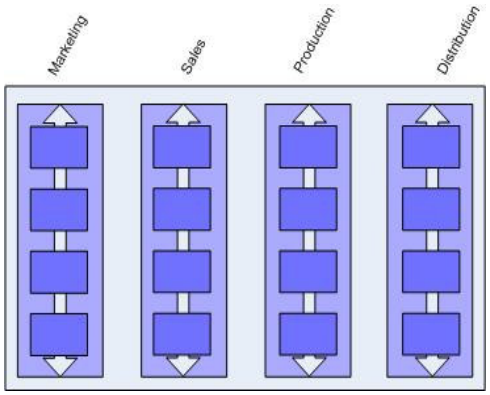


Figure 4-6 - Vertical integration

Value web integration
By integrating business processes with partners, suppliers or customers, an enterprise can speed up its business and improve its presence in the value web. This can lead to several advantages like loyal customers and more efficient suppliers. These increased levels of collaboration are becoming inevitable in a couple of years from now [CAP].

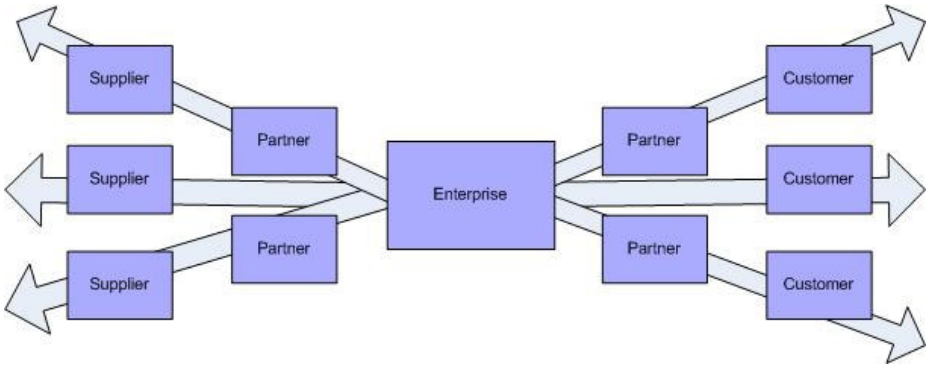


Figure 4-7 - Value web integration

When processes, infrastructure or applications are composed of modules, they must be well integrated. When they are not optimally connected and when business systems and applications remain disjointed, attempts to move, improve or reengineer them often prove very difficult and could require the development of costly custom connections, which leads to even more inflexibility.

The value of integration lays primarily in the increase of agility. With the increase of performance of internal operation and communication and collaboration with suppliers, new levels of service and performance can be achieved.

Rules:

- An enterprise must be aware of the advantages of integration.
- An enterprise must have sufficient internal value recognition in order to determine where integration initiatives can be of most value. With this recognition, holistic thinking is as equally important. An enterprise must break down barriers between vertical silos.
- An enterprise must integrate - by making use of *standardisation* - with other enterprises within the ecosystem.

Guidelines:

- An enterprise must connect processes within the organisation
- An enterprise must share technology/capacity as much as possible

Integration is important for every level within an enterprise. Integration on infrastructure level can already have many advantages. However, integration can create real value when business processes are integrated across the value-web.

The nature of this principle is mainly operational. It focuses on the integration of processes, systems, and information flows on an operational level. The principle is triggered by tactical and strategic principles like *external value recognition, internal value recognition* and *being variable.*

Quality attributes that are important are *construction* and *functionality*. Integration results in changes in the way business layers are constructed. Consequently, this results in finding new ways of derived functionality. Enabling things that were impossible before.

4.2.12 Maximisation of virtualisation

According to the online Oxford dictionary virtual means: not physically existing but made by software to appear to do so. In IT, virtualisation is mainly important for the infrastructure layer. This means that available resources are loosely linked. Separating infrastructure from applications contributes to an increase in flexibility, so that business processes, applications, and services can quickly and easily shift as needed [HP02]. The infrastructure appears virtual to the applications above. Infrastructure virtualisation can be done within network, storage, server and data centre. This also enables the dynamic and fast assignment of capacity to places where it is more required. Infrastructure can be used where and when needed, and reallocated on-demand when business and IT conditions change [GILL04].

Rules:

- Adaptive infrastructure must be independent from the applications above;
- Technology must be flexible so it can quickly be assigned to other purposes that are more in line with the current needs.

Guidelines:

- Technology should be scalable. Storage or other capacity should be scalable when needed.
- Technology should not be bound to physical limits.
- Technology should be commoditised as much as possible.
- Each component (*modularisation)*, either a service or infrastructural component should not be build for its peak usage. Load sharing enables redeployment for long or short period of use [FER03].

Virtualisation gets real with GRID technology. GRID technology was already shortly explained along with the principle of *modularisation*. A grid is a collection of distributed computing resources available over a network that appear to an end user or application as one large virtual computing system. With GRID technology, it is possible to have servers situated in London, New York and Amsterdam, while the system appears as one to the ones who use it. Some other characteristics of a GRID.

- It is middleware solution;
- It is not by itself either a product or a complete solution;
- Grids are built not bought;
- Grids are deployed not downloaded.

The main advantages of using Grid technology are:

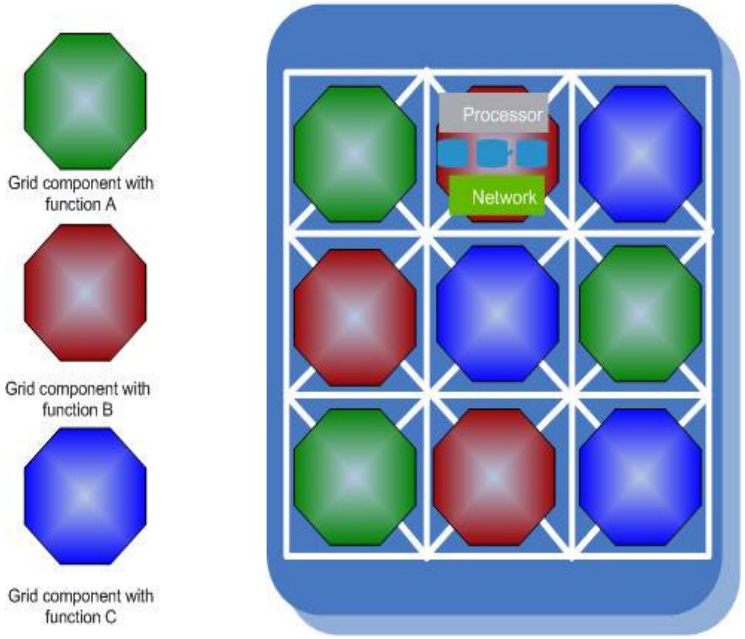


Figure 4-8 - Components in a GRID with different functionality, interconnected through standardised connections, contributing to a common goal

Financial:
- Share specialised resources;
- Take advantage of underutilised resources;

Agility
- Handle peaks and troughs in demand;
- Quickly deploy resources for new projects;

According to [HPDW-02] GRIDS will not become mainstream until 5 to 10 years from now. This is a hype phenomenon, because several providers already deploy commercial activities regarding GRID technology without having a matured solution. The solutions that customers are demanding are not inline with the solutions the providers can offer. This is also a result of a lack of awareness of the advantages of GRID computing with customers.

The nature of this principle is operational, it capitalises on the transformation of the lower levels of an enterprise, e.g. the application and infrastructural layer. This is done with the aim to achieve tactical goals like variability.

The quality attributes regarding this principle can be identified as functionality and construction. By restructuring infrastructure in a standardised way, letting it appear as one uniform system, new functionality can be offered to the users. Examples of additional functionality are: better availability, performance and scalability.

4.2.13 Maximisation of standardisation

From information level to infrastructure level, standardisation is extremely important. For this thesis, standardisation is defined as follows:

The development and implementation of concepts, doctrines, procedures and design to achieve and maintain the required levels of compatibility, interchangeability or commonality in the operational, procedural, material, technical and administrative field to attain interoperability [AMS].

Standardisation simplifies the context in which IT assets are deployed and used. Externally, the use of standards is important for communication with the ecosystem.

The value of standardisation lays in the use of components or even more important, the re-use of components. By adopting a standardised approach to how components/applications are designed, created, and deployed, they can easily be re-used for other purposes.

Rules:
- An enterprise must conform to industry standards for the exchange and format of data and information, platforms and software development techniques.
- An enterprise must ensure the use of off-the-shelf applications, technologies and components.
- An enterprise must be aware of why standardisation is needed and where it is needed throughout the enterprise.

Guidelines:

- An enterprise should use standard building blocks in constructing its infrastructure, application and information layer.
- Common requirements for manageability, security, version control, configuration management, capacity and performance management, and release-to-production processes should be defined.

Standardisation is the process in which something specialised and rare becomes standard, simple and common use. Eventually becoming a commodity. On infrastructural level, the technology of IP[12] is a good example. First, a data exchange protocol needed to be chosen, then IP became standard and now no one does even have to bother anymore about choosing a protocol because it is embedded. Standardisation has mostly occurred throughout the infrastructure layer; however, it becomes more and more important for the application, information and business layer. With the introduction and common application of ERP, CRM, and document management systems standardisation is moving upwards.

Standardisation is a principle with an operational background. It is about implementing standards within layers of an enterprise that eventually contribute to a tactical goal like the maximisation of simplification for example.

The main quality attribute regarding standardisation can be identified as the *construction* attribute. Standardisation contributes to a simpler and common applied approach in designing and implementing artefacts [CHAD04]. Indirectly, standardisation contributes to an increase in experience as shown in the figure below.

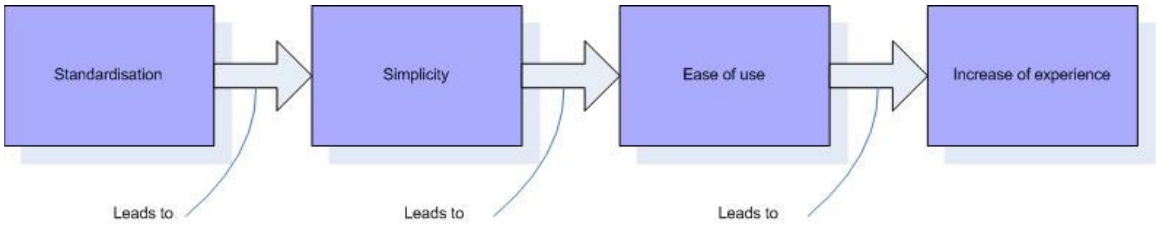


Figure 4-9 How does standardisation contributes to an increase of experience

4.2.14 Be as reactive as possible (sense and respond)

The sense and respond principle can be seen as the root principle for an adaptive enterprise. Already in 1999 Stephen H. Haeckel wrote his book 'Adaptive Enterprise, Creating and leading sense and respond organisations, defining the basics for almost every adaptive enterprise program'.

An enterprise must be able to sense market changes and react to them as fast and adequate as possible. It is important to be open to the ecosystem. Only then you are able to sense important changes and act proactively. Only if an enterprise is able to sense changes quickly the chances are bigger it will respond quickly. The process of responding relies on the capability of sufficient sensing. An enterprise can have adaptive capability, but if it cannot sense the market for things it should be adaptive to, adaptive capability is useless.

[12] Internet Protocol, the most basic protocol to communicate on the Internet.

To give the sense and respond principle more body, the actions taken within this principle will be clarified. This so called 'adaptive loop', originally defined by [HAECK99], defines four actions: Sense, Interpret, Decide and Act. These are shown in the figure below.

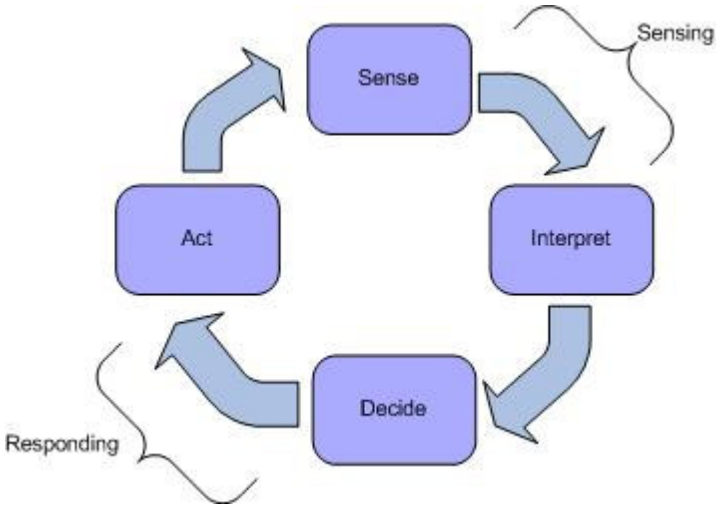


Figure 4-10- The adaptive loop

An adaptive enterprise must first *sense* what is going on within the ecosystem. After which meaningful signals need to be separated from noise, *interpreting.* The enterprise must then *decide* what to do in response. Finally, it should *act* upon that decision.

This principle is different from the *external value recognition* principle, because sensing and responding is about the *act* of reacting with speed and effectiveness. Recognising value is about being aware what the role of the enterprise is.

Rules:

- An enterprise must have the intelligence to sense market changes (threads & opportunities) as fast as possible. This results in a responsive and resilient organisation.

Guidelines:

- An enterprise should increase the number and density of connections to the outside world, to speed up information flow and adaptation.
- Comprehensive impact analysis of major changes. This enables a more proactive view of conflicts in the future.

This principle is situated within the business layer of an enterprise. The act of responding is however supported by the lower layers.

Being reactive is a tactical issue. It should initiate operational activities like business intelligence or marketing research in order to get feeling with the ecosystem. This principle is triggered by other strategic principles like *being innovative* and having *external value recognition*.

4.2.15 Close feedback loops

In literature about adaptive capability and the
element keeps coming back: the governance
enterprise. Originally taken from [SCHEK01
cycle of assessment, measuring, optimisation
and tuning them as fast as possible preve
Especially with regard to outsourcing, it is im
the processes you outsourced, that way those

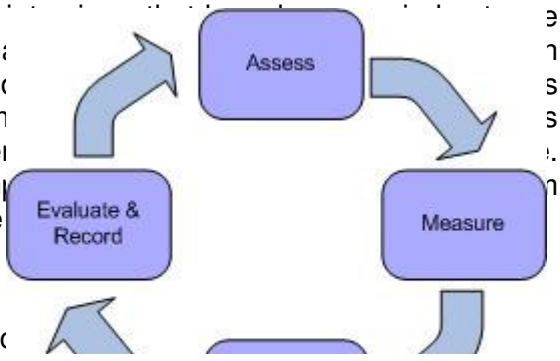


Figure 4-11 - Close feedback loop

An adaptive enterprise also establishes close feedback from connection channels with customers, suppliers, employees and competitors to give itself a better position in the ecosystem. This is usually facilitated by integration.

Within lower levels in the enterprise it is important to monitor.The number of things that require monitoring throughout the lower levels is relatively large. Think of the number of employees, the number of physical connections between internal and external infrastructure, and the number of distinct bits of information. All these things require to be monitored in order to be kept control of. For example in order to gain control of your infrastructure. It is important to have the ability to monitor and manage your network servers, storage, terminals, applications and databases. [HP03]

The real value of close feedback loops lies within three areas:

- Learning. Due to constant feedback, an enterprise learns from mistakes. It is however important to evaluate and record this feedback for future use.
- Leveraging. Using these feedback cycles an enterprise constantly optimises its performance.
- Governance. Using feedback loops an enterprise has tight control over every initiative, minimising the risk of failures.

Rules:

- An enterprise must constantly assess, measure, optimise and evaluate the initiatives it has taken.
- An enterprise must record, store and simplify the access to the information resulting from the evaluation process. This facilitates a learning organisation.
- An enterprise must maintain feedback loops on every level within the organisation.

Close feedback loops are situated within the business layer of an enterprise. However, in the future this might be a task that can also be performed at the application or infrastructural level. Think of a server that can dynamically can adjust its capacity according the actual demand. This results in self-healing, self-optimising (autonomic) systems that do not require interference with a human being anymore [GUT03].

The nature of this principle lies primarily in the tactical area. However, it uses operational elements to be measured and adjusted. It facilitates the strategic *internal value recognition* principle in that it provides insight in the status of initiatives and projects.

The quality attribute related to this principle can mainly be identified as *functionality*. By assessing and improving the operations of the enterprise, new functionality can arise while already present functionality can be improved.

4.2.16 Improve employee circumstances

In an adaptive enterprise, every element should have a degree of variability. Therefore, employees should be given the means to be as adaptive as possible. This can be done by creating an adaptive workspace. A workspace, which can dynamically change according to the demands of the employee, at any time, in any place, and on any device. If, for example, an employee is more productive at home, he should be given the opportunity to do so. According to research carried out by TNO Labour in 2004,

employees favour working time and place independent. Therefore, they should be given the means to do so.

The value of this principle lies within the notion that an enterprise cannot be adaptive if the parts that build up the enterprise are not adaptive! Employees remain the most important and valuable assets of every enterprise and therefore they should be as flexible as possible [HPDW-04].

Rules:

- An employee must have the opportunity to operate in every environment and on any device according to his preferences.
- An employee must have instant access to all required information for his activities.
- An enterprise must apply selective pressure to increase and ensure worker productivity.

Guidelines:

- There should be no barrier in accessing information. An employee should have instant access to all the information he is intended to use.
- An enterprise should not forget the importance of oral communication. The remaining existence of telephony stays important.
- An enterprise should have adaptive physical workspaces with characteristics like one shelf per employee, flex seats, quite space, hot desks and team spaces.
- An enterprise should provide the means for good education.

For this principle, several standards can be identified to facilitate it. These standards do not need further explanation.

Standards

- Single sign on;
- Notebooks;
- Tablet pc's
- IP telephony;
- Handhelds;
- Video conferencing

Employees play a central role in the operation of the enterprise, they must enable all distinct activities from which an enterprise is build up. That is why this principle is operational by nature.

The quality attributes that play a significant role within this principle are *functionality* and *experience*. An adaptive workspace is all about giving the employee the right functionality at the right time, so he can be as efficient and productive as possible. Regarding productivity, *experience* is important for the functioning of an employee. If an employee does not have a positive feeling operating in a workspace, it will be likely he will not be as productive as possible.

4.2.17 Interdependence

In the description of the distinct principles, the relationship between those principles was occasionally pointed out. In the figure below, you can see the distinct principles and see how they are related to each other.

Each relationship can be seen on *rule* level, it must be there. If for example an enterprise wants to introduce virtualisation techniques, it must first think of modularisation, and modularisation can not be carried out without a view of enterprise as a whole, facilitated by the holistic thinking principle.

The principles *being aware of the meaning of the adaptive enterprise concept* and *seeing IT as enabler* are seen as strategic design principles. They do not depend on, nor facilitate other principles.

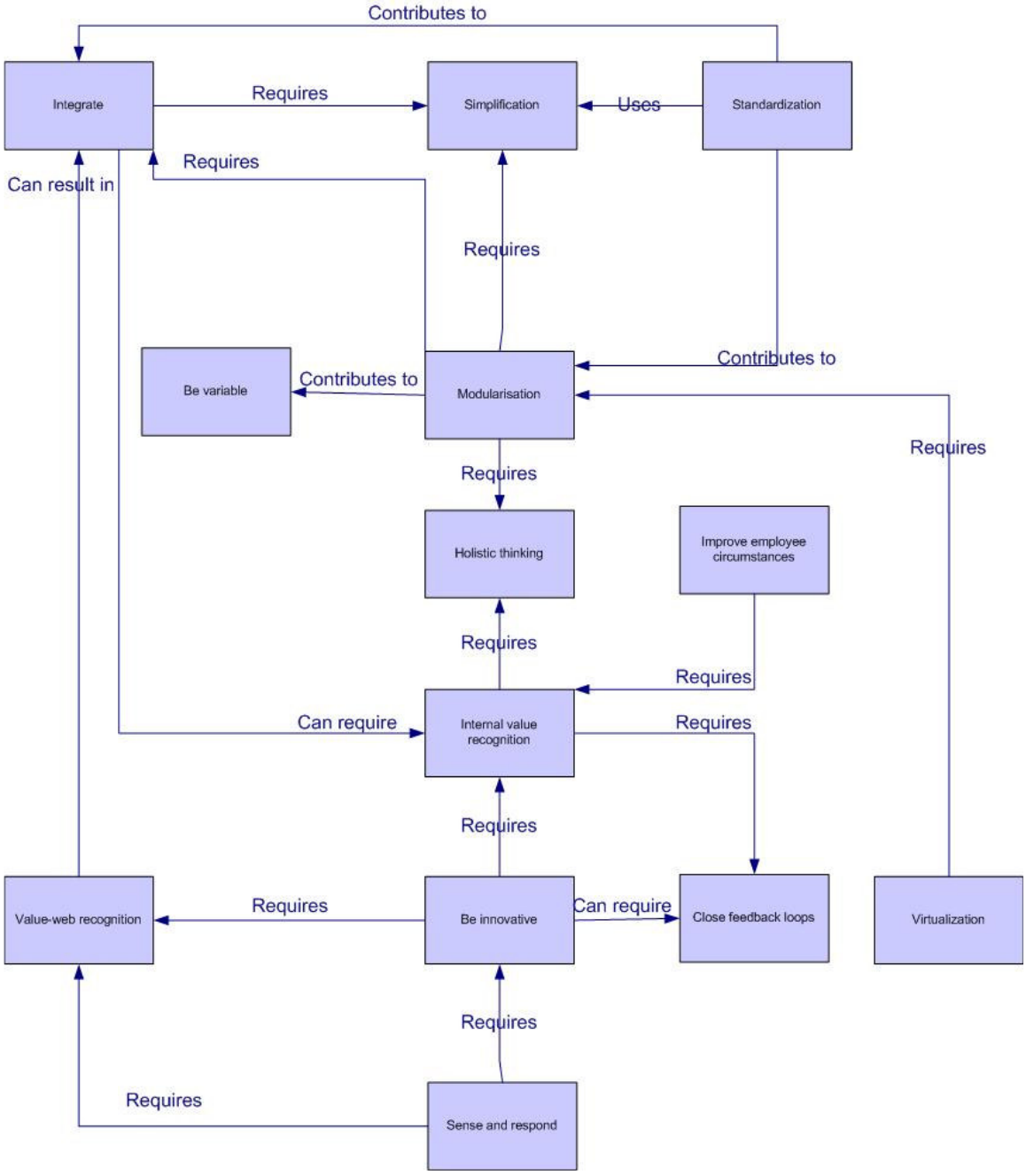


Figure 4-12 - Relationships between the principles of the adaptive enterprise

4.3 Positioning of principles in the framework

Visualising a 3D framework in which all principles of an adaptive enterprise are being situated is not feasible. That is why there is chosen for two 2D visualisation. In the first table, the principles are being projected on the *area of application* and *the quality attributes* for architecture. In the second table, the principles are projected on the area of application and the *nature* of the principle (strategic, tactical, and operational).

Quality Attribute / Area of application	Functionality	Construction	Experience
Business	• Be innovative (internal external) • Be aware of the meaning of the adaptive concept; • Recognising IT as an enabler of adaptive capability • Holistic thinking • External value recognition • Internal value recognition • Be variable • Maximisation of simplification; • Maximisation of integration; • Be as reactive as possible • Close feedback loops • Improve employee circumstances	• Be innovative (internal) • Holistic thinking • Be variable • Maximisation of simplification;	• Maximisation of simplification; • Improve employee circumstances
Information	• Be variable • Maximisation of simplification; • Maximisation of integration; • Improve employee circumstances	• Be variable • Maximisation of simplification; • Standardisation	• Maximisation of simplification; • Improve employee circumstances
Applications	• Be variable • Maximisation of simplification; • Maximisation of integration; • Close feedback loops	• Maximisation of modularisation • Be variable • Maximisation of simplification; • Maximisation of virtualisation • Maximisation of standardisation	• Maximisation of simplification; • Maximisation of virtualisation;
Infrastructure	• Be variable • Maximisation of simplification; • Maximisation of integration; • Close feedback loops	• Maximisation of modularisation • Be variable • Maximisation of simplification; • Maximisation of virtualisation; • Maximisation of standardisation	• Maximisation of simplification;

Table 4-1 - Principles projected on the area of application and the quality attributes

As you have read throughout the preceding paragraphs, principles can demonstrate through multiple areas simultaneously. From table 4-1 it is clear that most principles of an adaptive enterprise focus on *functionality* and reside in the *business* layer of an enterprise. Table 4-2 shows that most principles are also strategic and tactical by nature. The conclusion can be drawn, that if an enterprise is aware of its capabilities and the function it can carry out within the ecosystem, the most important step is made towards the creation of adaptive capability. The real accomplishment of these goals, facilitated by several operational principles, will follow naturally. Of course, the battle has not been fought yet, but a good strategy is half the work.

Nature / Area of application	Strategic	Tactical	Operational
Business	• Be innovative (internal external) • Be aware of the meaning of the adaptive concept • Recognising IT as an enabler of adaptive capability • Holistic thinking • External recognition • Internal value recognition	• Holistic thinking • Be variable • Maximisation of simplification • Be as reactive as possible • Close feedback loops • Improve employee circumstances	• Maximisation of integration • Maximisation of modularisation
Information		• Be variable • Maximisation of simplification	• Maximisation of integration • Maximisation of modularisation • Maximisation of standardisation
Applications		• Be variable • Maximisation of simplification	• Maximisation of modularisation • Maximisation of integration • Maximisation of standardisation • Maximisation of virtualisation
Infrastructure		• Be variable • Maximisation of simplification	• Maximisation of modularisation • Maximisation of integration • Maximisation of standardisation • Maximisation of virtualisation

Table 4-2 - Principles projected on area of application and nature

4.4 The ultimate adaptive enterprise

In this paragraph an overview will be given on the most important advantages that are enabled by the principles that have been described.

4.4.1 Consideration on the ultimate adaptive enterprise

Let's pose first that the ultimate adaptive enterprise does not yet exist. According to the Metagroup, real adaptive enterprises are only about to arise in 5 to 10 years from now. Techniques that should enable adaptive capability are just about to arise and are not mature enough. Lastly, the implementation of adaptivity is expensive. Of course it does

depend on the degree of flexibility and agility that is already present within an enterprise. However, the realisation of several adaptive enterprise principles is not cheap. Think about the construction of enterprise architecture to facilitate holistic thinking and a migration path for the enterprise, or the implementation of GRID technology.

This does not mean that today's enterprises cannot show adaptive behaviour with the means they have now. The definition of an adaptive enterprise for this thesis states that it can react with *speed, ease,* and *effectiveness* to changes in the ecosystem. If an enterprise would react with speed and effectiveness to a change in the ecosystem, but it appears harder to accomplish then originally planned, the enterprise is still adaptive, it only takes a bit longer. Today's enterprises also have to react to changes in order to survive, every entity, system, or organism is constantly subject to changes that require action. There is some degree of adaptive capability in all of them; however, the difficulty lies in the ease, speed and effectiveness with which the reaction is performed.

4.4.2 Enabled advantages

What are the advantages that are enabled by the principles named in the preceding paragraph? Throughout the description of the principles, one or more advantages were named for each principle. Below, you can find the common advantages enabled by all of the principles together.

- An adaptive enterprise knows when and where value can be created. With the use of sufficient value-web recognition and the notion of which innovations can be effective, an enterprise can create competitive advantage. It also knows how to create value by optimising its internal processes and resources (including employees).
- Reduction of complexity enables a faster implementation of changes within the enterprise.
- An adaptive enterprise is capable of adapting its internal structures to changing business demands. This is facilitated by modular, standardised and integrated application- and infrastructure layers.
- An adaptive enterprise is constantly assessing and optimising itself in order to learn and optimise operation in the future.

These four points are just as the principles named in the preceding paragraph, set up according to the opinion of the IT service providers.

4.4.3 Comparing visions on the ultimate adaptive enterprise

In general it can be stated that the service providers embark on the same journey, with the same goal. The goal to create flexible and cost efficient enterprises. However, their programs differ in their approach and naming. Some service providers give more attention to the creation of adaptive capability on the lower levels within an enterprise; others pay more attention to business layers, focussing on the awareness. These differences have their natural cause in the origin and core competencies of the service providers. For example, IBM and HP deliver infrastructural products and services already for many years, making it no surprise that their main attention goes to creating adaptiveness in the infrastructural layers of an enterprise. Although they have programs that encompass the creation of adaptivity enterprise wide. Companies like Capgemini and the Metagroup are more business and service oriented by nature, and therefore focus more on the application, information and business layer.

In practice, these kind of different enterprises tend to collaborate more and more in delivering solutions for their customers. Also, they become aware of their core competencies and know how to use the core competencies of others in the value-web. According to [TOL-I] and [APPEL-I], collaboration is going to be the next big thing within business. Collaboration emphasises and extents the *external value recognition* principle of an adaptive enterprise.

The difference in naming of the principles can have its cause in commercial and marketing reasons. It simply does not sell if an enterprise would have the same naming and interpretation to a concept as a competitor. It would be harder to make clear that their solution is better.

As mentioned earlier, the main adaptive enterprise programs of the IT service providers differ in naming and sometimes in interpretation. However, when conducting interviews with representatives of those enterprises, all other aspects of an adaptive enterprise where mentioned, regardless of their own particular program. For example, all respondents mentioned *innovation* as one of the most important enablers of the creation of value. While innovation was never mentioned within any of the main principles of the IT service providers.

In the table below you can find the most important principles for the adaptive enterprise program of each IT service provider. The cells marked in grey correspond to the principles that are most emphasised within the marketing strategy of an enterprise.

This table has been set up according to the interviews that have been carried out and the literature these enterprises have provided for this research.

IT service providers / Principles	Cap Gemini	HP	IBM	Metagroup
be innovative	X	X	X	X
be aware of the meaning of the adaptive concept				X
be aware of seeing IT as an enabler of adaptive capability	X		X	X
holistic thinking	X	X	X	X
external value recognition	X		focussed	X
internal value recognition	X		focussed	X
maximisation of modularisation	X	X	X	X
being as variable as possible	plug and play		X	
maximisation of simplification		X		
maximisation of integration		X	X	
maximisation of virtualisation		X	X	X
maximisation of standardisation	X	X	openness	X
being as reactive as possible	read and respond		X	X
applying and eventually increasing the number of close feedback loops	learn and leverage		autonomic	
improving employee circumstances		X	X	X

Table 4-3 - Which IT service provider is using which principle in their adaptive enterprise strategy. An 'X' means they give extensive attention to this principle within their adaptive enterprise program. The cells marked in grey are part of the core adaptive enterprise program. Unmarked cells do not necessarily mean no attention is paid to that principle at all, it is just less represented.

The Metagroup does not have a uniform adaptive enterprise program in which several key (design) principles are defined. In their view, an adaptive enterprise needs to embody all principles marked in table 4-3.

4.4.4 Conclusion

The first sub question for this research has been defined as:

What are the essential requirements to which an IT intensive enterprise has to comply in order to be adaptive to changes in the ecosystem, according to the providers of IT services? These requirements will be formulated into several architectural principles

All 15 principles described in this chapter are important for creating adaptive capability. No enterprise exists today with all these principles implemented, resulting in the ultimate adaptive enterprise.

Each IT service provider gives attention to different principles. However, there are large commonalities in their strategy. These could be summarised as:

- An adaptive enterprise knows when and where value can be created. With the use of sufficient value-web recognition and the notion of which innovations can be effective, an enterprise can create competitive advantage. It also knows how to create value by optimising its internal processes and resources (including employees).
- Reduction of complexity enables a faster implementation of changes within the enterprise.
- An adaptive enterprise is capable to adapt its internal structures to changing business demands. This is facilitated by modular, standardised and integrated application and infrastructure layers.
- An adaptive enterprise is constantly assessing and optimising itself in order to learn and optimise operation in the future.

The next chapter describes how the principles described in this chapter are being brought to practice, and which principles can be applied to certain business initiatives areas.

5 Applying principles to business initiatives

In this chapter, the results of the second part of the research project are presented. In this part, the experiences with aspects of an adaptive enterprise in practice have been found out. Through a survey several enterprises have been interviewed that deal with the concept of adaptive enterprise in their business. The questions that will be answered in this chapter are:

- What is the perception of an adaptive enterprise in practice?
- How does an enterprise see the aspects of an adaptive enterprise implemented within their own business, now and in the future?
- Which of the principles stated in chapter four are regarded essential for an adaptive enterprise, and which of them are regarded less essential.

The detailed results of the survey and the validation for the questions within the survey can be found in appendix A. This formed the most important input for this chapter.

5.1 The business initiative framework

In this paragraph, the most important principles for each business initiative area (BIA) visualised in figure 2-2 will be clarified. These are the areas that have been described in chapter two – *the need for an adaptive enterprise.*

5.1.1 Strategic supplier policy

The following principles have been identified by the survey as important for this BIA:

- External value recognition;
- Internal value recognition;
- Maximisation modularisation;
- Maximisation of standardisation.

Knowing what other enterprises within the ecosystem have to offer and how an enterprise can cater to this notion are the most important aspects for this area. On a strategic and tactical level, an enterprise has to know where value can be created. The eventual result of this notion on an operational level might be the integration with a provider or customer, or even an outsourcing deal. This is subsequently facilitated by a modular organisation of the functions involved in the integration allowing for an easy displacement. As stated in chapter four, standardisation is important for the success of modularisation, and therefore for activities like outsourcing [TOM03].

5.1.2 Mergers and acquisitions

For this business initiative area, the following principles have been rated important:

- External value recognition;
- Maximisation of simplification;
- Internal value recognition.

For mergers and acquisitions, it is important to have sufficient notion of the benefit of the result of a merger or acquisitions. This notion should be present at a strategic level. While merging two enterprises it is important to focus on simplification. Just tying two

enterprises together results in multiple and often redundant IT systems, information streams and processes. The benefit of a merger is only achieved when similar processes (together with their applications and infrastructure) are effectively integrated. Creating an enterprise architecture facilitates this process.

5.1.3 Legislation

Complying with legislation in a fast and cost effective way is an important issue of adaptivity. Most of the time it must be fast and in most cases it does not even create direct value. That is why the two most important principles for this BIA have been identified as;

- Be reactive as possible;
- Be variable.

Sensing and responding are the two key elements in the reaction process. Since the government will let you know, one way or the other, to comply with legislation, the *responding* part is most important. The process of responding is subsequently facilitated by a variable attitude and structure throughout the enterprise. In the case of influential laws during the last 10 years the Sarbanes Oxley and Clinger-Cohen act both focussed on a transparent and open business structure that requires significant changes within the internal operation of an enterprise.

Other principles that have been regarded important are the principles of *standardisation* and *the use of close feedback loops.* Conforming to industry standards contributes to the process of being future proof. Making sure that legacy systems are not created. Close feedback loops enable the governing of the process of complying with legislation. Complying with legislation does not just involve complying once, but complying constantly. Enterprises change constantly, conscious and unconsciously, therefore a controlling mechanism needs to be present to validate the compliance to legislations.

5.1.4 Customer care

The following principles have been identified important for the relationship with customers:

- External value recognition;
- Close feedback loops;
- Be innovative.

The main idea behind these three principles is the creation an emotional relationship with customers. Knowing what they want and anticipating on their demand, maybe even before the customer makes this demand explicit. Having notion of where innovation can be required to meet customer needs can create significant value. The creation of this notion is mainly facilitated by the use of close feedback loops with customers.

5.1.5 Operational excellence

The business initiative area of operation excellence focuses on the internal functioning of an enterprise. Regarding this internal functioning, the following principles have been identified:

- Maximisation of simplification;

- Improving employee circumstances;
- Maximisation of standardisation;
- Be variable.

All these principles pay attention to an optimisation of the efficiency with which an enterprise operates. A maximisation of standardisation and simplification contributes to the ease with which an enterprise has insight in, and can change its internal processes. In order to react effectively to changing business needs, the internal operation of an enterprise has to be as variable as possible. Other principles that have been mentioned with regard to this variability are those of *modularisation, internal value recognition,* and *integration.* The relationship between these principles could also be derived from figure 4.7.

As stated in chapter four, employees are the most important assets of an enterprise. If they do not operate efficiently and with pleasure, any initiative imposed by the business is likely to fail. To support operational excellence, the improvement of employee circumstances has also been rated important.

5.1.6 Employee functioning

Regarding the business initiative area of employee functioning, the principle of *improving employee circumstances* has not surprisingly been pointed out as most important. Besides this principle, the following principles have also been identified important:

- Improving employee circumstances
- Internal value recognition;
- Be variable;
- Maximisation of simplification.

The possession of internal value recognition is important in order to know where employees can be positioned best. Human Resource Management plays an important role here.

Having a certain degree of variability and not implying to many rules and regulations within an enterprise, gives employees the opportunity to be innovative. It is employees that have to execute the process of innovation, something very essential for an adaptive enterprise.

5.1.7 Product innovation

The principle of *being innovative* has been rated most important for the BIA of product innovation.
Other than the principle of *innovation*, there are several other principles that have importance for the business initiative area of product innovation, these are:

- Be innovative;
- Internal value recognition;
- Being as variable as possible;
- Maximisation of simplification.

For a new, and lets presume, innovative product it is also important to be suitable and fitting for the intended customers

In literature about innovation and in some comments in the survey, it is made clear that product innovation is not only about the creation and optimisation of real products. It is about the complete product portfolio an enterprise has to offer, including services. A service is in this case also regarded as a product.

5.2 Principles in practice

This paragraph describes the results of the survey with special attention to the meaning and perception of an adaptive enterprise. The survey consisted of several questions that had the aim to first derive the respondents interpretation of an adaptive enterprise and secondly, letting the respondent comment on the presented information.

5.2.1 Non prejudiced perception of an adaptive enterprise

The first question within the survey was to give a definition of adaptive enterprise in the respondents own words. By first asking this question the respondents would not be prejudiced in their answer with information provided later on in the survey. With the merger of several similar definitions and characteristics, the following list of definitions is set up.

- An adaptive enterprise is capable of dealing with uncontrollable forces like the business drive and the technology push. Assuming that legislation will lead to a business drive.
- An adaptive enterprise is capable of anticipating in time, to market changes or internal lacks of value.
- An adaptive enterprise uses collaboration with other enterprises in the ecosystem to drive new ways of value creation.
- An adaptive enterprise is able of adapting to changing market circumstances and IT possibilities with the highest possible efficiency and reaching business goals with the lowest costs.
- An adaptive enterprise is able to react actively as well as proactively to market changes by having a thorough vision on its core business and how it evolves.
- An adaptive enterprise effectuates product innovation proactively and reactively.

The main concept throughout these definitions is the creation of value by anticipating quickly and effectively to market changes. It are the concepts of *cost reduction, value creation,* and *speed* that are apparently most important to respondents of this survey.

Other characteristics of an adaptive enterprise

Other than the characteristics resulting from the definitions given above are listed below.

An adaptive enterprise should:

- see opportunities instead of difficulties. An enterprise should embrace change, it is confronted with, instead of run away from it;
- timely discover changes by performing thorough business intelligence;
- be aware of the necessity of adaptivity;
- be sensitive to internal and external changes and use innovation to cater to these changes;
- measure new initiatives to see if they comply with predefined goals;

- have learning capabilities. Actions should not stand on their own, but should have their impact on the enterprise for future initiatives;
- have a holistic view of the organisation on boardroom level;
- have insight in consequences of changes, changes that affect the enterprise or changes that are effectuated by the enterprise itself;

With these results it can be concluded that the focus of the abilities of an adaptive enterprise lays in having awareness. For an adaptive enterprise, it is important to be aware of every aspect within the organisation and all other enterprises within its ecosystem. Awareness is an important prerequisite for adaptivity.

This also corresponds with the answers to question two. That question was asked to obtain information on the elements that are either adaptive or not within the respondent's enterprise. It turns out that customer initiatives are pointed as most adaptive. Internal processes and people are mostly regarded not adaptive. This originates from a lack of awareness.

5.2.2 Prioritisation of principles

The principles listed in chapter four have been presented to the respondents in order to be prioritised. The goal was to identify how these principles are possibly implemented within certain enterprises, compared to each other. This research project did not have the goal to identify how certain aspects of adaptivity could be measured. For example, I cannot make any statement whether to judge if an enterprise is innovative or not. It is up to the respondents to judge, according to their own interpretation, if their enterprise has certain aspects of adaptivity. The criterion on which the principles have eventually been prioritised is thus the comparison between the principles themselves, not an individual criterion for each principle.

In the survey the respondents have been asked to rate each principle. One could choose between the following three options:

- Very important for the enterprise: the absence or failure of the principle would be disastrous for the enterprise.
- Important for the enterprise: the principle is important for the operation of the enterprise and it does contribute to the adaptive capability it owns. However, the failure of the principle would not lead to a disastrous effect for our core business;
- Negligible for the enterprise: the principle does not have any role of importance for the enterprise.

Furthermore, the respondents have been asked to give this prioritisation for the situation in their enterprise now, and the likely situation in their enterprise in 5 years from now. This gives an impression of how the respondents see the evolution of the adaptive enterprise principles in their own organisation. The graph in table 5-1 gives the result of this question. The datasheet that is used for the construction of this graph is presented in appendix A.

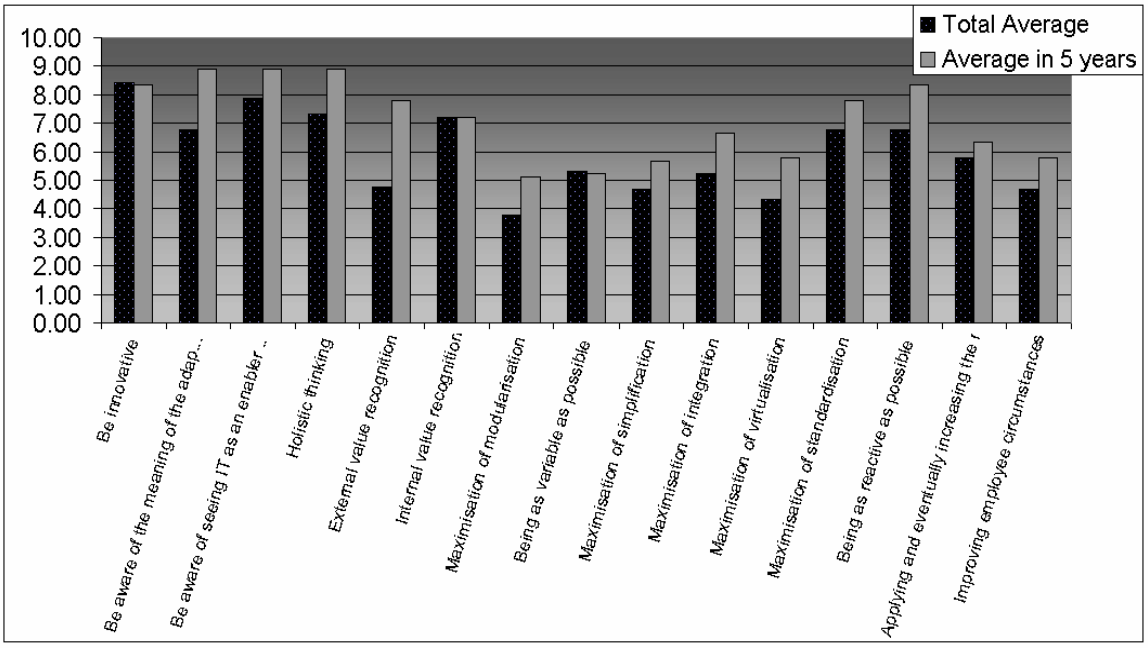


Table 5-1 - Interpretation of principles now and in 5 years from now

The black bars indicate the present average situation in the respondents' enterprises; the grey bars indicate the expected average situation in 5 years from now.

As also concluded from the preceding paragraph, there is much attention for the strategic principles and less attention for the operational principles that facilitate adaptive capability. Operational principles that are given less attention are those of *simplification* and *virtualisation*. Principles that have a strategic character are regarded more important. Without those, it is useless to initiate activities with operational principles. For example, why would an enterprise modularise certain aspects of its organisation if it does not know its intended purpose or where modularisation is most needed? Tactical and operational principles can therefore be seen as a consequence of several strategic principles.

The two principles that are regarded most important nowadays are those of *innovation* and the principle of the *awareness of IT as enabler*. The possible reason why innovation is chosen as most important – and in 5 years from now, less important – is that innovation is a concept that is really hyped over the last 2 years. Several IT service providers have put this topic high on the agenda, which could be the cause that innovation is a very known and perceived important topic. Another reason for the high rating of innovation is simply the promises innovation makes and the advantages it can offer. Advantages and promises that have been discussed in chapter four.

IT is regarded as essential for the possible success of an adaptive enterprise, now and in the future. Apparently, enterprises finally accept the importance of IT in every aspect of today's business. This can be concluded from the high rating of the principle concerning the awareness of IT as enabler.

Regarding the differences between the interpretation of principles now, and in 5 years from now, can be concluded that almost every aspect is regarded more important in 5 years from now. It is natural that every enterprise sees itself steady moving forward by

improving their business and internal operations. However, there are some exceptions. There is a substantial increase of the perception of *external value recognition*. It is becoming increasingly important for an enterprise to recognise its function within the ecosystem and how it can create value according to that notion.

A principle that is regarded less important is that of modularisation. Apparently, enterprises do not yet see the importance of a modular approach to certain business layers that require adaptivity. There can be several reasons for this result. One reason could be that technologies for a modular infrastructure have not yet matured enough to demonstrate their advantage. Many of those techniques are actually still in development. On the other hand, modularisation on application level is already being deployed more extensively, especially through the use of loosely coupled web services. Web services can be seen as cheap components that can easily be linked to each other. The survey may not have been explicit enough about the concept of modularisation. This might also have been a reason that the respondents rated modularisation less important.

5.2.3 Comparison between interpretation and reality

The first paragraph in this chapter discussed the most important principles for each business initiative area. That paragraph pointed out how the principles of an adaptive enterprise contribute to real-life situations. With the same source data as in the first paragraph, the total rating of each principle is been looked at, regardless of the business initiative areas. This data provides information on how the principles for an adaptive enterprise are really being applied in practice. The resulting information would likely be identical to the information presented in sub paragraph 5.2.2.

The source data for the graph below can also be found in appendix A. In the graph below the results are presented.

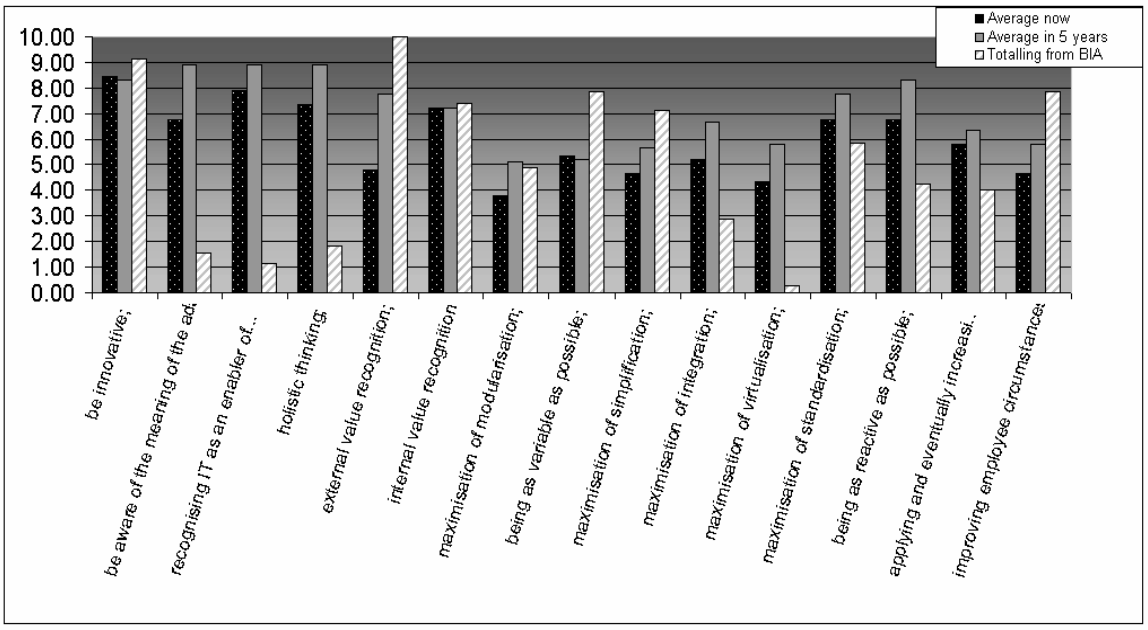


Table 5-2 - Interpretation of principles now (black), interpretation of principles in 5 years (dark grey), interpretation of principles according to business initiatives (white striped)

The black and grey bars are the same as in the graph in table 5-1. The white striped bar indicates the totalling of the principles according to the projection on the business initiatives areas. With the use of this graph, some conclusions can be drawn on the relationship between principles that are perceived to be or become important (black and grey bars), and principles that are applied to real-life problems (white striped bars).

One thing that immediately stands out is the choice for *external value recognition* as most important principle. Although the respondents do not perceive *external value recognition* to have a major importance, especially nowadays, it appears in practice that *external value recognition* is seen as the number one condition for an adaptive enterprise. The idea behind this is that an enterprise can internally be 100% adaptive, but if it does not know what to adapt to, adaptivity is useless.

A second thing that stands out is the low rating of strategic principles as being *aware of the adaptive concept*, *recognising IT as enabler* and *holistic thinking*. Apparently, these principles do not directly drive value and are therefore not primarily chosen to cater to real-life changes.

Virtualisation is not regarded as important as several IT service providers suggest. Virtualisation is a solution that involves technology that has not matured enough to be proven effective. This could be a reason that *virtualisation* is not chosen as solution for the enabling of adaptive capability.

5.3 Conclusions

The second sub question for this research has been defined as:

How are the main architectural principles, resulting from sub question 1, being brought tc practice and what are the experiences with these?

In the answer of this sub question a distinction has been made between the principles that have been rated compared to other principles, and principles that have been rated according to their application to real business initiative areas.

The first group has been described in paragraph two of this chapter. Most attention goes to principles that have a strategic character and are concerned with having awareness of where and how to apply or create adaptive capability. This is mainly perceived as *where* and *how* to create value. Principles that ground this notion are those of *external value recognition, being reactive, being variable* and *being innovative.* Enterprises find it important to find new ways of value creation, this can only be done with a good notion of where a lack of value is present (*external value recognition),* creating this notion in time (*being as reactive as possible)*, and making sure it is done with the right product for the right target group (*innovation).*

The prioritisation of principles that is derived from the totalling of the principles for the business initiative areas gives some other significant results. On one hand, it confirms the previous conclusion stating that *external value recognition* and *innovation* are two very essential elements of an adaptive enterprise. On the other hand, it concludes that

principles that do not directly drive value or principles that are relatively new are not regarded important. Principles like *being aware of the adaptive concept* and *seeing IT as enabler* are not primarily regarded important for the creation of adaptive capability.

6 Conclusions

In this chapter, the conclusions of the research project will be summarised. Resulting from the answer to the sub-questions, the main research question is answered. Furthermore, this chapter is used to give some additional comments on the concept of the adaptive enterprise in relation to other phenomena.

6.1 Conclusions

In chapter two of this thesis you have read about the need for adaptive capability resulting from the several distinct changes and challenges an enterprise can be confronted with. These have been formulated as *complexity, control, change* and *costs.* The answer to the research question gives an overview how these challenges can be faced.

6.1.1 Sub question 1

The first sub-question has been defined to define principles for an adaptive enterprise in order to overcome the challenges an enterprise can be confronted with. It has been defined as:

What are the essential requirements to which an IT intensive enterprise has to comply in order to be adaptive to changes in the ecosystem, according to the providers of IT services? These requirements will be formulated into several architectural principles

As mentioned in chapter four, the principles that have been defined according to the conducted interviews and literature study are the following:

1. be innovative;
2. be aware of the meaning of the adaptive concept;
3. recognising IT as an enabler of adaptive capability;
4. holistic thinking;
5. internal value recognition;
6. external value recognition;
7. maximisation of modularisation;
8. be variable;
9. maximisation of simplification;
10. maximisation of integration;
11. maximisation of virtualisation;
12. maximisation of standardisation;
13. be as reactive as possible;
14. close feedback loops;
15. improve employee circumstances.

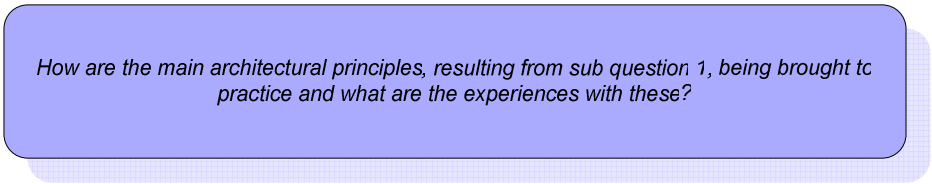
One of the results that have come out of the research is that these principles can be divided into three main groups. They can be strategic, tactical or operational by nature. The strategic principles are mostly concerned with awareness. Awareness of *why* adaptivity is needed, *what* the changes are that require adaptivity, *where* it is needed, and *how* adaptive capability is created. These are the principles 1, 2, 3, 4, 5, 6.

In addition, several tactical principles can be distinguished (8, 9, 13, 14, 15). These principles all have their nature in things that need to be done. Here, you can think of principles like *be variable, be reactive, and being innovative.* These principles are supported by means of operational principles (7, 8, 10, 11, 12).

The visions of the IT service providers used for answering this sub question were in the end quite similar. However, there are differences throughout the main ideas of their adaptive enterprise program. Enterprises like IBM and HP, that offer infrastructural solutions for their customers, tend to focus more on the tactical and operational principles. These principles alone are not enough to make an adaptive enterprise migration path successful; the right strategic principles need to be present to guarantee acceptance, support and awareness throughout the entire enterprise. Concluding from the interviews with IBM and HP, they do focus on strategic principles, but these are not part of their main adaptive enterprise strategy.

6.1.2 Sub question 2

The second sub question being defined is the following.



Without being prejudiced with information provided in the survey, the respondents defined an adaptive enterprise as an enterprise along with the following characteristics:

- It creates value by reacting flexible and timely to changes in an ecosystem that is full of uncontrollable forces.
- It creates value knowing its position in the ecosystem and uses that notion to collaborate with other enterprises.
- It knows where the internal operation in an enterprise lacks efficiency and thus where optimisation is required. This can be done by innovating through the optimisation of internal processes.
- It uses product innovation proactively, as well as actively. This means for example that an enterprise is capable of interpreting the desire of a customer, before the customer himself is aware of its own desire.

A distinction has been made in the answering of this sub question. Principles have been rated compared to each other. And principles have been rated according to their application to business initiative areas.

From the first prioritisation of principles it can be concluded that the strategic principles have been rated most important. Apparently, one finds it important for an adaptive enterprise to be aware of the capabilities IT can offer, and to obtain a holistic view of the enterprise. Other strategic principles that have been rated important are those of recognition of external and internal value. These principles seem to be the trigger for several more tactical and operational principles, like modularisation and integration. This

seems logical, because it would be unwise to initiate modularisation initiatives without knowing where to apply them!

From the principles that the respondents applied to the business-initiative-areas it can be said that more tactical principles have been rated with higher importance than several strategic principles. While initiating business initiatives one finds it important to:

- Have sufficient notion of external value recognition;
- Be innovative;
- Be variable.

The choice for these three principles is more in line with the initial opinion of the respondents on the adaptive enterprise. It is important to create value as soon as possible by making use of the right innovations.

6.1.3 Full research question

The full research question for this research project has been defined as:

What are the essential requirements to which an IT intensive enterprise has to comply in order to be adaptive to changes in the ecosystem? These requirements will be formulated into several architectural principles

The opinion of the IT service providers on the adaptive enterprise concept, together with experiences from the field have been used to answer this question. The IT service providers primarily focus on the creation of adaptivity throughout all the layers of an enterprise (business to infrastructure). The goal is to create an agile and flexible enterprise that is capable of adapting to business needs or other circumstances within the enterprise. The main concern of enterprises that want to be adaptive is *how* and *where* value can easily be created. Therefore, they give more attention to principles that are concerned with the creation of value, like innovation and the awareness of external and internal value recognition.

Operational principles can be seen as a result of the choice for certain tactical and strategic principles. Realising a virtualised infrastructure is very expensive and requires sufficient common acceptance. This is emphasised by the results of the survey. One finds the presence of tactical and strategic principles more important than those of operational principles.

Another conclusion is that enterprises in practice do not yet have sufficient feeling with certain operational principles that facilitate the capability of being adaptive. Having a modularised and virtualised infrastructure is not regarded as the number one requirement for the creation of adaptive capability. This is caused by the fact that the technologies facilitating virtualisation for example, have not yet matured enough to prove their advantage. The technologies that are present are still very expensive.

6.2 Considerations on the adaptive enterprise

This paragraph gives attention to the concept of the adaptive enterprise in a broader perspective. The first sub paragraph gives attention to several distinct concepts that

relate to the adaptive enterprise and how these are currently being applied. The second sub paragraph discusses the process of becoming an adaptive enterprise. Many IT service providers pay thorough attention to how their customers should become adaptive. The last sub paragraph discusses the relationship between an adaptive enterprise and an intelligent enterprise.

6.2.1 Adaptive, On-Demand, Utility computing and GRID computing

The power of an enterprise to react to changes in the ecosystem with ease, speed, and effectiveness is given many names in practice. These differences in naming often suggest a real fundamental difference; however, this is not always the case. [GILL04] gives an overview of all IT service providers that provide (partial) solutions for the creation of adaptive capability. These initiatives go by names like *harmonious computing, agile computing, managed computing and dynamic systems.* Forrester calls it even *organic IT*. Of course there are some fundamental differences in some of these approaches, but most obtain the same goal. For now, the relationship between the concepts of *adaptive, on demand, utility computing* and *GRID* computing is being discussed.

On demand
The concept of on demand has already been introduced by Steven Haeckel in the 90's as an essential characteristic of an adaptive enterprise. It was positioned as having the capability of requiring resources or functionality instantly, on demand, *when* it was required and *where* it was required. In this interpretation on-demand can be seen as a delivery model, very closely related to utility computing.

The interpretation of *on demand* is different when it is seen in the context of the adaptive enterprise program of IBM. On demand is their (marketing) term for the adaptive enterprise strategy. The core of this strategy is to do business on-demand. The on-demand strategy of IBM is fully comparable with the adaptive enterprise strategy of for example HP.

Utility and GRID computing
Utility and GRID computing are techniques and initiatives that enable part of the adaptive concept. These concepts are not interchangeable with the concepts *adaptive* and *on demand.* Utility and GRID computing mostly facilitate adaptive capability on the application and infrastructural layer. But also those concepts can not be implemented in an enterprise without sufficient strategic goals and principles. They facilitate adaptive capability, but cannot guarantee adaptive behaviour.

Utility computing
Utility computing is a concept in which users pay for functionality on a pay-per-use basis, just as it is the case with electricity and water. The idea behind this concept is simple; why would you pay for services you do not (fully) use? IBM is selling small computing cycles to its customers; SUN unveiled a pay-as-you-go service that allows customers to run computing jobs on SUN's servers for $1 per processor/storage/memory hour. HP just recently announced plans to sell high-level processor functionality by means of an auction. Small enterprises that do not have the possibility of executing complex calculations can buy processor time by means of an online auction. This is based on the principle: the higher the demand is, the higher the price will be. Since December 2004, 3D animating companies like Dreamworks, BBC and Watershed can make use of advanced rendering utilities at HP. For now, this service remains free while the project is

still an experiment. However, in the near future these companies would have to pay for this functionality. [AUT-05#7]

GRID computing
As mentioned in chapter four, GRID computing is still maturing, evolving from a marketing idea to real-life operation. Two major reasons for the slow growth of GRID computing can be recognised. On one hand, the technology to facilitate GRID computing has not yet matured enough. On the other hand, the market is not yet convinced about the advantages GRID computing can offer. Two major projects have been launched by several IT providers to promote the advantages of GRID computing.

- Global Consortium (HP, IBM, Sun and Intel)
- Project MegaGrid (EMC, Dell, Intel and Oracle).

The stagnation in the maturing of the technology is mainly caused by the lack of (open) standards. Project MegaGrid will try to introduce small and relatively cheap components for the creation of GRID's, while simultaneously creating and implying standards. [AUT-05#7]

6.2.2 Becoming an adaptive enterprise

Many IT service providers pay attention to the process that has to be undertaken in order to become adaptive. This is a very interesting topic that could be appropriate for future research. Here, some comments will be given on this process.

Before an enterprise wants to embark on a journey to increase its adaptive capabilities, it must first pay attention to the following issues:

- The willingness to become adaptive must be present throughout the entire enterprise. This contributes to the support the migration plan will have. If the employees of an enterprise do not have a flexible attitude towards the changes they are confronted with, it is not likely that the migration will succeed.
- An enterprise must understand the fundamental idea of *why* it is necessary to become adaptive. This also contributes to the support for the migration plan.
- Lastly, the enterprise - and especially the management – must be aware of the fact that adaptive capability is **created**, **not bought**. And that it takes a reasonable amount of time to implement it. An enterprise does not become adaptive overnight.

If the things mentioned above are present within the enterprise, the process of becoming adaptive can really begin. It starts with identifying the places within the enterprise that require adaptive capability most. Preferably, it needs to be a small area so if the initiative would fail, it would not have major consequences. In this way, experience can be gained for future and larger initiatives. During the transformation process several milestones need to be defined on which progress is evaluated. This relates to the close feedback loop principle.

Implementing adaptive capability is expensive. In general, it are large projects in which thorough analysis and designing needs to be performed, usually by third parties. This requires a lot of time and resources that are not cheap. That is why all IT service providers addressed for this research say it is wise to start small and let the

transformation pay for itself. Reinvest the savings of a successful initiative into a new initiative.

6.2.3 Adaptive enterprise in relation to intelligent enterprise

The concept of the intelligent enterprise has been extensively treated throughout the business and academia. Because one can define several similarities between the concept of the adaptive enterprise and the intelligent enterprise, some comments are given on this relationship.

First of all, a definition of an intelligent enterprise is given.

An intelligent enterprise is able to transform itself into better and optimised forms by becoming intelligent [DEL&DAY03]. Intelligent is defined as: the ability to acquire and apply knowledge and skills [OXFORD].

The concept of the intelligent enterprise finds its origin in the comparison of biological systems to engineered systems. Both systems share the same objective: to survive in an evolving environment and changing circumstances. The first similarity with an adaptive enterprise is made clear: they both have to deal with changing circumstances.

In order to achieve the objective mentioned above. The intelligent enterprise should be able to sense and respond to its environment, and most importantly, learn from it. This learning capability is crucial for a natural progress and optimisation for the future. This is the same with natural systems. A child is constantly sensing and responding to its environment, experimenting with things and challenging its parents. It learns from the reactions it receives in order to move to a higher level of intelligence.

For the comparison of these two concepts, a definition of the characteristics of an intelligent enterprise according to [DEL&DAY03] has been used:

- It is agile – it is able to react fast to the input it receives.
- Adaptive, self regulating, self optimising – it is able to adjust its business to changing circumstances.
- Self defensive – as biological systems are also self defensive with biologically inspired resistance mechanisms.
- With fuzzy borders, a mesh like structured – it is able to restructure the organisation to fit to it dynamic needs, as is the case with outsourcing for example.
- Self aware – aware of the market and learn from them and adapt to them.
- Able to morph into new and better forms. This is a long-term process in which the result may not even be clear. It is clear that it involves major structural transformations.

Here you can see that ‘adaptive’ is mentioned as an attribute of an intelligent enterprise. While other attributes are also conditions for an adaptive enterprise, like being *agile* and being *self-aware*. This illustrates the overlap that these two phenomena have. An intelligent organisation however, is more autonomic and self-regulating than an adaptive enterprise. This comes from the idea that this kind of enterprise has automated its

learning and adaptive capability with the least possible interference of human beings. Adaptive enterprises should also have learning capabilities in order to leverage themselves to become more mature. However, in an adaptive enterprise this process is defined and managed, in an intelligent enterprise this process is optimised and automated.

This leads to the conclusion that an adaptive enterprise is not naturally an intelligent enterprise, but an intelligent enterprise is surely adaptive.

6.3 Future research

This master research project has not been extensive enough to cover the concept of the adaptive enterprise entirely. Several areas have been left uncovered that can be possible subject to future research, and therefore can be of great value for the area of information science. You can think of:

- Defining the need for adaptive capability for small enterprises and large enterprises. What are the differences that can be recognised?
- How can adaptivity be measured? Several IT service providers give direction for the measurement of certain aspects of the adaptive concept. However, it lacks a real uniform measure. A measure that will certainly require adjustments for different kinds of enterprises, but can be of great value for the migration to an adaptive enterprise.
- Many IT enterprises now focus on the creation of an adaptive structure of their enterprise. I believe that the solutions offered for those challenges will commoditise in the next decade. This will lead to a movement in attention from internal optimisation to 'external' optimisation. How can an enterprise sense market changes actively and proactively? What are the techniques, methods and principles required for creating optimal feeling with the ecosystem? These are questions that can be of good input for possible future research.

Another reason why research on the adaptive enterprise could be intensified in the future is that more and more enterprises get experienced with the principles and advantages adaptivity has to offer. This leads to new visions and possible optimisation of current concepts. All this can be input for more research in the future.

Appendix A: Survey results

Validation for the questions within the survey

The goals and the order of the questions as they were stated in the survey will shortly be described.

Question 1
The goal is to obtain the respondents idea of the definition of an adaptive enterprise. It functions as a simple introductory question trying to force the respondent to think of the real need for an adaptive enterprise. The question focuses on characteristics without being biased with information provided in subsequent questions.

Question 2
The goal is to obtain information on how certain aspects of an adaptive enterprise are present or not present in the respondents enterprise. These are the aspects that the respondent mentioned in question 1. This question can be seen as a 'mirror' question. Letting the respondent think on how the situation actually is within his own enterprise. Likely the respondent has provided a 'to-be' situation in question 1, and will now describe an 'as-is' situation in question 2.

Question 3
The goal is to obtain information on how the principles of an adaptive enterprise are present in the respondent's enterprise. These are the principles that have been defined in the first part of the research. The distinction between now and the situation in five years is made to obtain information on which principles the respondent's enterprise will mostly focus in the near future. What will *become* or *is* a trend.

Question 4
The goal is obtain information of the level in the enterprise the main focus goes to in creating adaptivity. Later, this information could be mapped to prioritisations resulting from other questions. The answers to this question have been too diverse from the eight respondents to the survey in order to provide enough input for a conclusion. That is why the results of this question have been omitted from appendix A. They did not contribute to the goal of the survey.

Question 5
The goal is to obtain information on the principles that can best be used to cater to changes that occur within certain initiative areas. Except for this information, the answers to this question also tell how these principles really live in practice. Principles that are not applied to any initiative area are apparently not perceived important. This idea is extensively discussed in paragraph 5.2.2. As you can see in the answers to question 5, not all respondents have answered this question.

Enquête - Karakteristieken van een Adaptive Enterprise
Deze enquête gaarne binnen twee weken terugsturen naar het volgende e-mail adres:
Bas.Verbruggen@student.ru.nl

Vraag 1
Er zijn verschillende opvattingen over hoe de ideale adaptieve onderneming is vormgegeven en wat adaptiviteit inhoudt. Deze vraagt tracht uw opvatting ten aanzien van het begrip 'Adaptive Enterprise' vast te stellen.
Kunt u een definitie geven van een adaptieve onderneming? Denk hierbij aan eventuele vaardigheden die een onderneming moet hebben, acties die ze uit moeten voeren en de reden voor adaptiviteit.
… … … … … ……
… … … … … ……

Kunt u een aantal kenmerkende activiteiten of karakteristieken van een adaptieve onderneming opnoemen?
… … … … … ……
… … … … … ……
… … … … … ……
Opmerkingen:
……

Vraag 2
Uitgaande van de definitie die u hierboven gegeven heeft:
Zijn er dan bepaalde facetten of onderdelen binnen uw onderneming die u als adaptief beschouwd? Zo ja, waarom?
……
……

Zijn er bepaalde facetten of onderdelen die u niet als adaptief beschouwd? Zo ja, waarom?
……
……

Zijn er facetten of onderdelen die u niet als adaptief beschouwd maar dit wel zouden moeten zijn? Zo ja, waarom?
… … … … … ……
… … … … … ……

Opmerkingen:
……

Een definitie
Onder een adaptieve onderneming verstaan wij een onderneming die snel en doelgericht kan inspelen op veranderingen in het ecosysteem. Dit kan een onderneming bewerkstelligen door adaptief vermogen te creëren en vervolgens te combineren met een notie van waar en hoe dit adaptief vermogen kan worden toegepast.

Deze definitie zegt niets over de verschillende karakteristieken of capaciteiten die een adaptieve onderneming dient te hebben. Deze definitie geeft alleen een duidelijke

scheiding tussen wat een onderneming moet *hebben* èn wat een onderneming moet *doen.* Deze twee facetten kunnen verder worden uitgewerkt.

Vraag 3
Karakteristieken van een adaptieve onderneming
De eerste fase van dit onderzoek had tot doel alle mogelijke karakteristieken van een adaptieve onderneming te achterhalen. Deze karakteristieken kunnen worden teruggebracht naar de volgende vijftien.

- Innovativiteit. Waarde creëren door het bedenken van nieuwe concepten of combineren van bestaande. Ook het stoppen van initiatieven die niet aan de verwachting voldoen is innovatie!
- Bewust zijn van de impact van adaptiviteit. Een onderneming moet weten wat adaptiviteit betekent, hoe men het (gedeeltelijk) wordt en waarom het noodzakelijk is.
- ICT zien als enabler voor een adaptieve onderneming.
- Holistisch denken.
- Overzicht hebben over de gehele onderneming. Dit kan d.m.v. een enterprise architectuur.
- Waardeketen bewustzijn. Een onderneming moet zich bewust zijn van zijn rol in de waardeketen / ecosysteem. Het strategisch sourcen kan hier een belangrijk onderdeel van zijn.
- Intern waarde bewustzijn. Een onderneming moet zich bewust zijn van de plaatsen in de onderneming waar de meeste waarde gecreëerd wordt en waar het minst.
- Optimalisatie van de modularisatie. Een onderneming (van bedrijfsprocessen tot aan infrastructuur) moet zoveel mogelijk worden opgedeeld in beheersbare (kleine) componenten.
- Zo variabel mogelijk zijn. In elke laag van een organisatie (bedrijfsprocessen, informatie, applicatie en infrastructuur) alsmede binnen elke verticale laag (business unit, LOB of afdeling) moet zoveel mogelijk variabiliteit worden ingebouwd om zo snel mogelijk flexibel op veranderingen in te kunnen spelen;
- Zoveel mogelijk simplificeren. Het reduceren van complexiteit in bedrijfsprocessen, applicaties, connecties en infrastructuur draagt bij tot een beter overzicht, eventuele optimalisatie en een grotere bestuurbaarheid.
- Integreren. Integratie van bedrijfsprocessen, informatiestromen en infrastructuur voor optimalisatie en simplificatie.
- Standaardiseren. Standaardisatie draagt bij tot een verbetering van de connectiviteit met de rest van de entiteiten binnen ecosysteem. Het afwijken van standaards werkt averechts voor nieuwe initiatieven.
- Virtualiseren. Het scheiden van de afhankelijkheid van de applicaties met hun infrastructuur.
- Zo reactief mogelijk zijn. Open en alert zijn naar het ecosysteem om veranderingen snel waar te nemen en hier vervolgens op in te spelen.
- Maximaliseren van terugkoppelmomenten. Het onder controle houden van nieuwe en bestaande initiatieven.
- Maximaliseren van werknemer omstandigheden, zodat deze de kans krijgen zo goed mogelijk te functioneren. Denk hierbij aan beschikbare werkruimte, de soort werkruimte, informatie, en de snelheid tot toegang tot deze informatie.

Welk van de bovenstaande karakteristieken spelen momenteel een rol in uw onderneming met het doel een verhoging van uw adaptief vermogen te creëren? En

welk van deze karakteristieken verwacht u een grote rol te gaan spelen over 5 jaar? In onderstaande tabel kunt u aankruisen hoe u hier over denkt.

- Van groot belang. Deze karakteristiek is van essentieel belang. Het ontbreken of wegvallen van deze karakteristiek zou desastreus zijn voor de gehele onderneming op de lange termijn.
- Speelt enige rol. Deze karakteristiek is van belang voor het functioneren van de onderneming en geeft een daadwerkelijke toevoeging aan het adaptieve vermogen. Echter, het ontbreken of wegvallen hiervan zou geen grote consequenties hebben.
- Verwaarloosbaar. Deze karakteristiek speelt geen enkele rol in de bedrijfsvoering.

Zet een kruisje in het bijbehorende hokje.

	Nu			Over 5 jaar		
Karakteristiek / Relevantie	Groot belang	Enige rol	Verwaar-loosbaar	Groot belang	Enige rol	Verwaar-loosbaar
Innovativiteit						
Bewust zijn van adaptiviteit						
ICT als enabler zien						
Holistisch denken						
Waardeketen bewustzijn						
Interne waarde bewustzijn						
Modulariseren						
Variabel zijn						
Simplificeren						
Integreren						
Virtualiseren						
Standaardiseren						
Zo reactief mogelijk zijn						
Terugkoppelmomenten verhogen						
Maximaliseren van werknemer omstandigheden						

Opmerkingen:

……

Vraag 4

Voor deze vraag gaan we er van uit dat een onderneming bestaat uit de volgende 5 aandachtsgebieden. Deze aandachtsgebieden zijn vaak terug te vinden in beschrijvingen voor architectuurraamwerken.

- Strategie. Hierin is de bestaansreden van een onderneming vastgelegd en wordt het beleid (voor de komende jaren) vastgelegd.
- Business. In deze laag vinden alle bedrijfsprocessen plaats.
- Informatie. In deze laag bevindt zich het informatieverkeer (inclusief kennismanagement en communicatieruimtes) dat nodig is om de bedrijfsprocessen in de business laag te doen functioneren.
- Applicaties. In deze laag bevinden zich alle applicaties waarmee de informatie wordt verwerkt.
- Infrastructuur. In deze laag bevindt zich alle technologie en middelen om de applicatielaag te ondersteunen.

Geef aan in hoeverre karakteristieken voor een adaptieve onderneming momenteel een rol spelen in elk aandachtsgebied van uw onderneming.

- Grote rol. Principes en ideeën aangaande adaptiviteit zijn niet meer weg te denken.
- Belangrijke rol. Principes en ideeën aangaande adaptiviteit spelen een belangrijke rol, maar zijn niet essentieel voor het slagen van de bedrijfsvoering.
- Onbelangrijke rol. Er spelen zich totaal geen zaken aangaande adaptiviteit af in deze laag.

Zet een kruisje in het corresponderende hokje.

Belang / Laag	Grote rol	Belangrijke rol	Redelijk onbelangrijk
Strategie			
Business			
Informatie			
Applicaties			
Infrastructuur			

Opmerkingen:
……

Vraag 5
Veranderingen in het ecosysteem doen zich voor in de vorm van uitdagingen of bedreigingen. Pas op het moment dat deze een concern [13]gaan vormen voor een onderneming, worden ze belangrijk. Business initiatieven, in de vorm van projecten, of strategische beslissingen kunnen uiteindelijk een antwoord gaan vormen op deze veranderingen. Veranderingen, concerns en business initiatieven kunnen zich voordoen op de volgende gebieden.

Strategisch leveranciers beleid
Denk hierbij aan out en insourcen van activiteiten. Activiteiten kunnen ook leverancier gerelateerd zijn.

Fusies en overnames
Het ontstaan van uitdagingen of bedreigingen aan de hand van fusies of overnames.

Wetgeving gerelateerd
Denk hierbij aan het conformeren aan wet en regelgeving vanuit de overheid of EU.

Klant intimiteit
Veranderende klantenkring, veranderende klant wensen en eisen.

Interne operationaliteit
Het interne functioneren van een onderneming. Denk hierbij aan veranderingen van processen, infrastructuur of management.

Medewerker functioneren
Denk hierbij aan veranderingen die direct gerelateerd zijn met het functioneren van een of meerdere medewerkers.

Product innovatie
Het product ondervindt veranderingen. Het product voldoet bijvoorbeeld niet meer aan de huidige kwaliteitsnormen of wensen van de klant.

Omdat er uiteindelijk business initiatieven plaatsvinden op deze gebieden zullen we deze gebieden voortaan business-initiatief-gebieden noemen. In samenspraak met professionals is deze lijst opgesteld. De lijst beoogt niet volledig te zijn, maar voldoende indicatief voor een categorisering van de knelpunten waar een hedendaagse onderneming mee geconfronteerd wordt.

Voor elk van deze gebieden kunnen bepaalde karakteristieken uit vraag 3 van belang zijn teneinde het adaptief vermogen op dat gebied te vergroten. De verschillende karakteristieken zijn dus uit te zetten tegen de bovengenoemde gebieden. Men krijgt vervolgens het raamwerk op de volgende pagina.

[13] Het resultaat van het vaststellen van een uitdaging of bedreiging welke voor een onderneming een impact kan hebben. Voldoende business intelligence is nodig om vast te stellen welke gebeurtenissen ook daadwerkelijk een bedreiging vormen. Daarna is het zaak om deze bedreiging tot een concern te vertalen welke uiteindelijk als input kan dienen voor een business initiatief.

Voor elk business-initiatief-gebied kunt u de drie belangrijkste karakteristieken aangeven. Dit doet u door de getallen 1 tot en met 3 voor elk business-initiatief-gebied eenmalig te verdelen tussen de karakteristieken. De getallen 1 tot en met 3 hebben de volgende betekenis:
1: van extreem belang;
2: van groot belang;
3: van belang.

De 12 karakteristieken die overblijven zijn van minder belang of zijn totaal te verwaarlozen voor dat bepaalde business-initiatief-gebied. Eventuele opmerkingen kunt u onderaan de pagina plaatsen.

Business initiatief gebied / Karakteristiek	*Strategisch leveranciers beleid*	Fusies en overnames	Wetgeving gerelateerd	Klant gerelateerd	Interne operationaliteit	Medewerker gerelateerd	Product innovatie gerelateerd
Innovatief zijn							
Bewust zijn van adaptiviteit							
ICT als enabler zien							
Holistisch denken							
Waardeketen bewustzijn							
Interne waarde bewustzijn							
Modulariseren							
Variabel zijn							
Simplificeren							
Integreren							
Virtualiseren							
Standaardiseren							
Zo reactief mogelijk zijn							
Het aantal terugkoppelmomenten verhogen							
Maximaliseren van werknemer omstandigheden							

Opmerkingen:
……

Hartelijk dank voor uw medewerking.

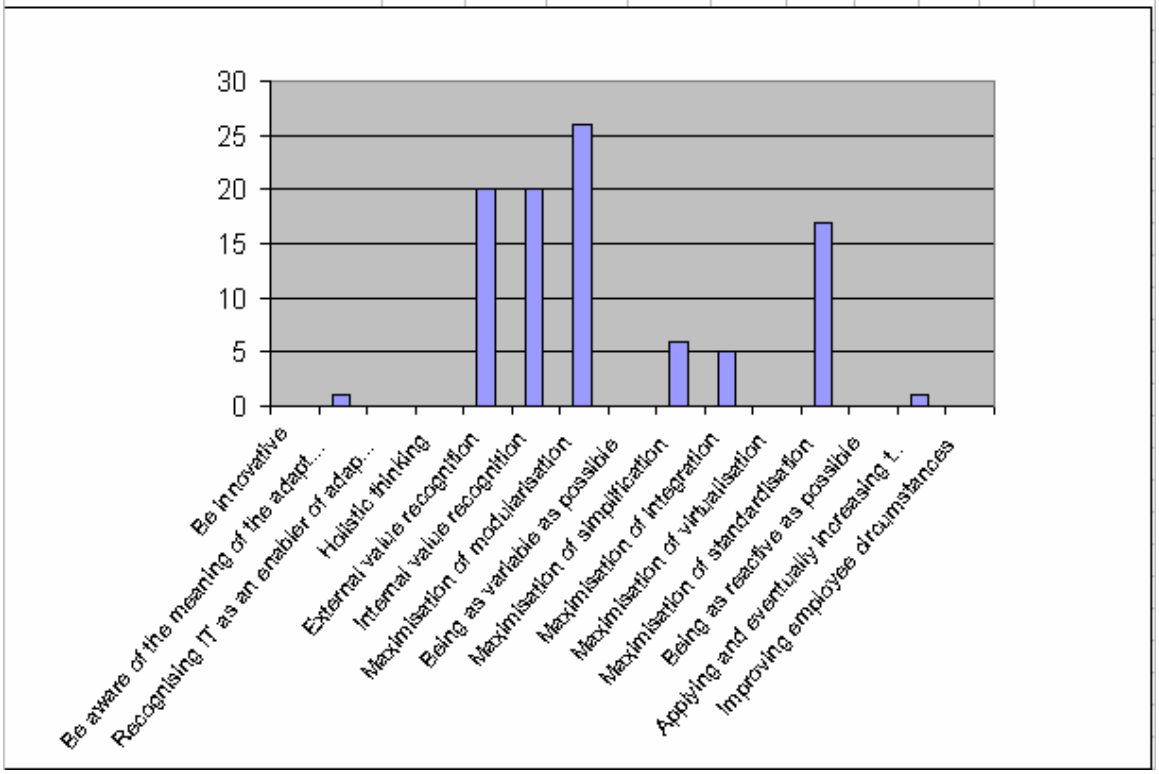
S.W. Verbruggen

Results from question 3

Companies / Principles	Company 1		Company 2		Company 3		Company 4		Company 5		Company 6		Company 7		Company 8		Company 9		
	Now	5 Y	Now	5 Y	Now	5 Y	Now	5 Y	Now	5 Y	Now	5 Y	Now	5 Y	Now	5 Y	Now	5 Y	Total n
Be innovative	1	5	5	10	10	5	10	10	10	10	10	5	10	10	10	10	10	10	
Be aware of the meaning of the adaptive concept	5	5	5	10	5	10	10	10	10	10	5	10	1	5	10	10	10	10	
Recognising IT as an enabler of adaptive capability	10	10	10	10	10	10	5	5	5	5	1	10	10	10	10	10	10	10	
Holistic thinking	10	10	5	10	5	10	10	10	10	10	1	5	10	10	5	5	10	10	
External value recognition	10	10	1	5	1	5	5	10	10	10	5	10	1	10	5	5	5	5	
Internal value recognition	5	5	5	10	5	10	10	10	10	10	10	5	10	5	5	5	5	5	
Maximisation of modularisation	10	5	1	1	1	10	5	5	5	5	1	5	1	5	5	5	5	5	
Being as variable as possible	1	1	1	5	1	1	10	10	10	10	5	5	10	5	5	5	5	5	
Maximisation of simplification	1	1	5	10	5	5	10	10	5	5	5	5	1	5	5	5	5	5	
Maximisation of integration	5	5	5	5	10	5	5	10	10	10	1	10	1	5	5	5	5	5	
Maximisation of virtualisation	1	1	5	5	1	5	1	1	10	10	1	5	5	10	10	10	5	5	
Maximisation of standardisation	5	5	10	10	5	10	10	10	10	10	1	5	10	10	5	5	5	5	
Being as reactive as possible	1	5	5	10	5	10	5	5	10	10	5	5	10	10	10	10	10	10	
Applying and eventually increasing the number of close feedback loops	1	1	5	5	5	5	10	10	1	1	5	10	10	10	10	10	5	5	
Improving employee circumstances	1	1	5	5	5	5	5	10	1	1	5	10	10	10	5	5	5	5	
																			Total A
1 = Neglectible	5 = Important				10 = Essential														

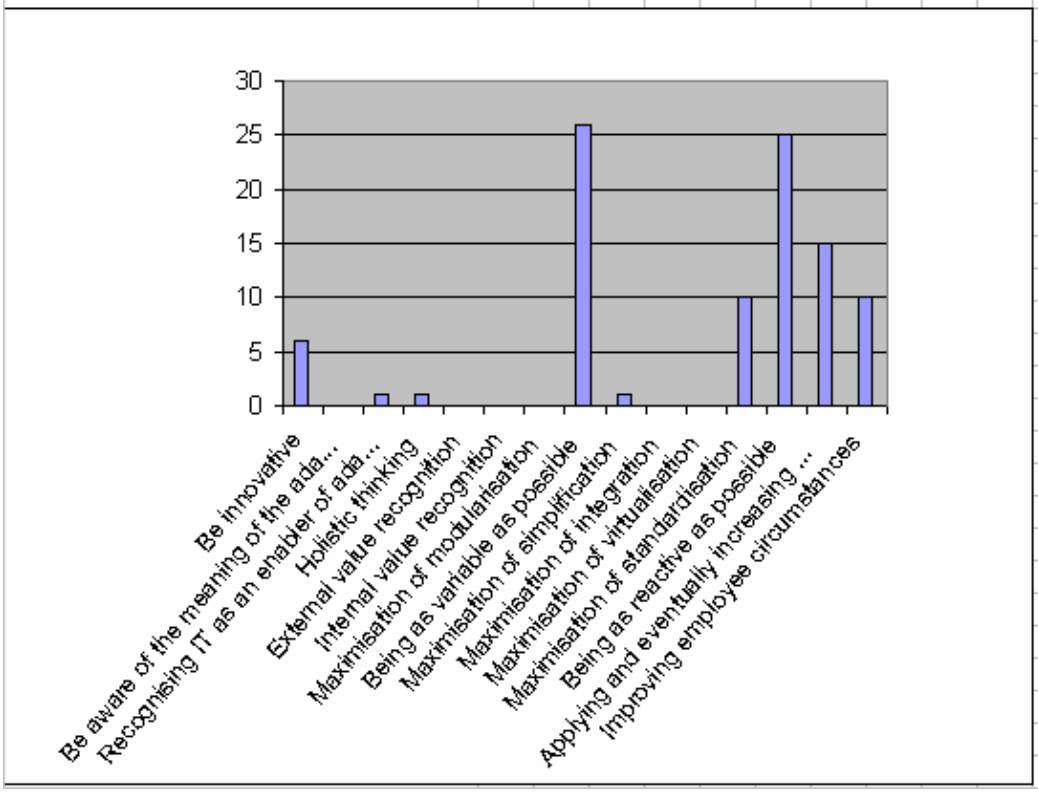
Results from question 5: Strategic Supplier Policy

Principles/Respondent	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7	Company 8	Company 9	Totaal
Be innovative										0
Be aware of the meaning of the adaptive concept			1							1
Recognising IT as an enabler of adaptive capability										0
Holistic thinking										0
External value recognition					10		10			20
Internal value recognition		10	5		5					20
Maximisation of modularisation			10	5	1	10				26
Being as variable as possible										0
Maximisation of simplification				1			5			6
Maximisation of integration						5				5
Maximisation of virtualisation										0
Maximisation of standardisation		5		10		1	1			17
Being as reactive as possible										0
Applying and eventually increasing the number of close feedback loops		1								1
Improving employee circumstances										0



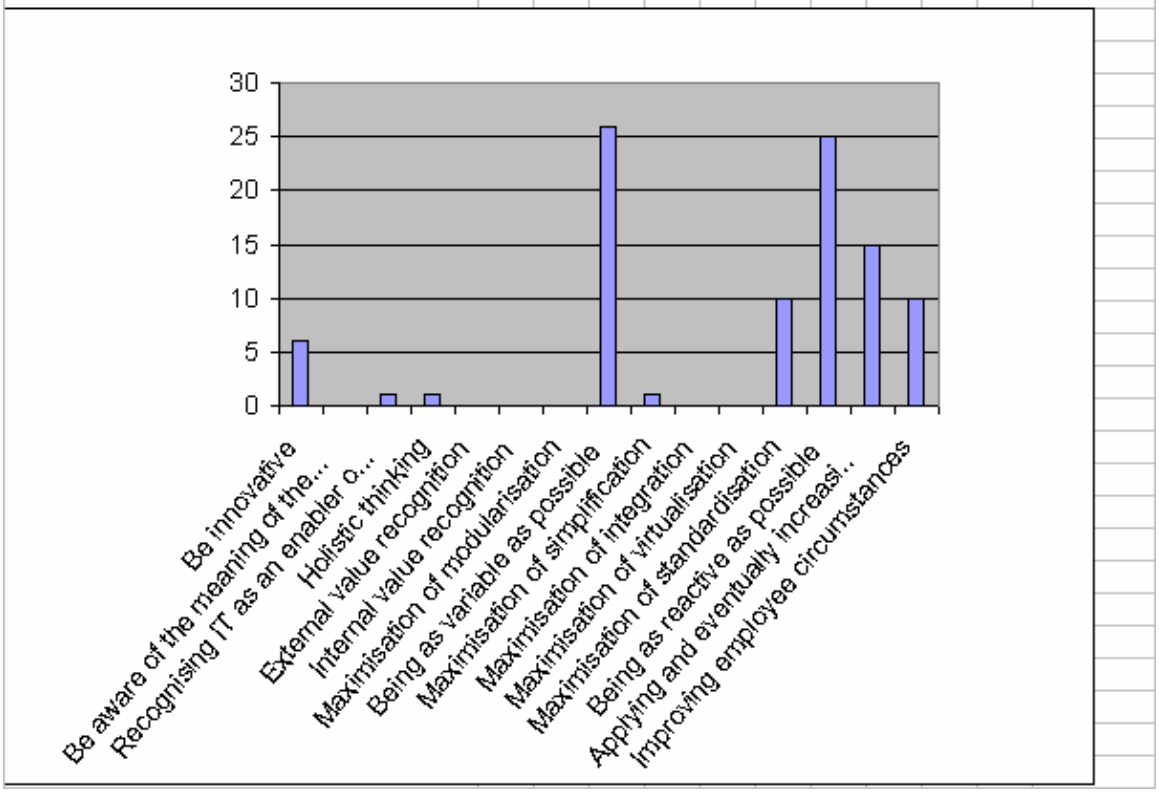
Results from question 5: Mergers and acquisitions

Principles/Respondent	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7	Company 8	Company 9	Totaal
Be innovative				5			1			6
Be aware of the meaning of the adaptive concept										0
Recognising IT as an enabler of adaptive capability						1				1
Holistic thinking			1							1
External value recognition										0
Internal value recognition										0
Maximisation of modularisation										0
Being as variable as possible		10		1	10		5			26
Maximisation of simplification		1								1
Maximisation of integration										0
Maximisation of virtualisation										0
Maximisation of standardisation			5			5				10
Being as reactive as possible					5	10	10			25
Applying and eventually increasing the number of close feedback loops		5		10						15
Improving employee circumstances			10							10



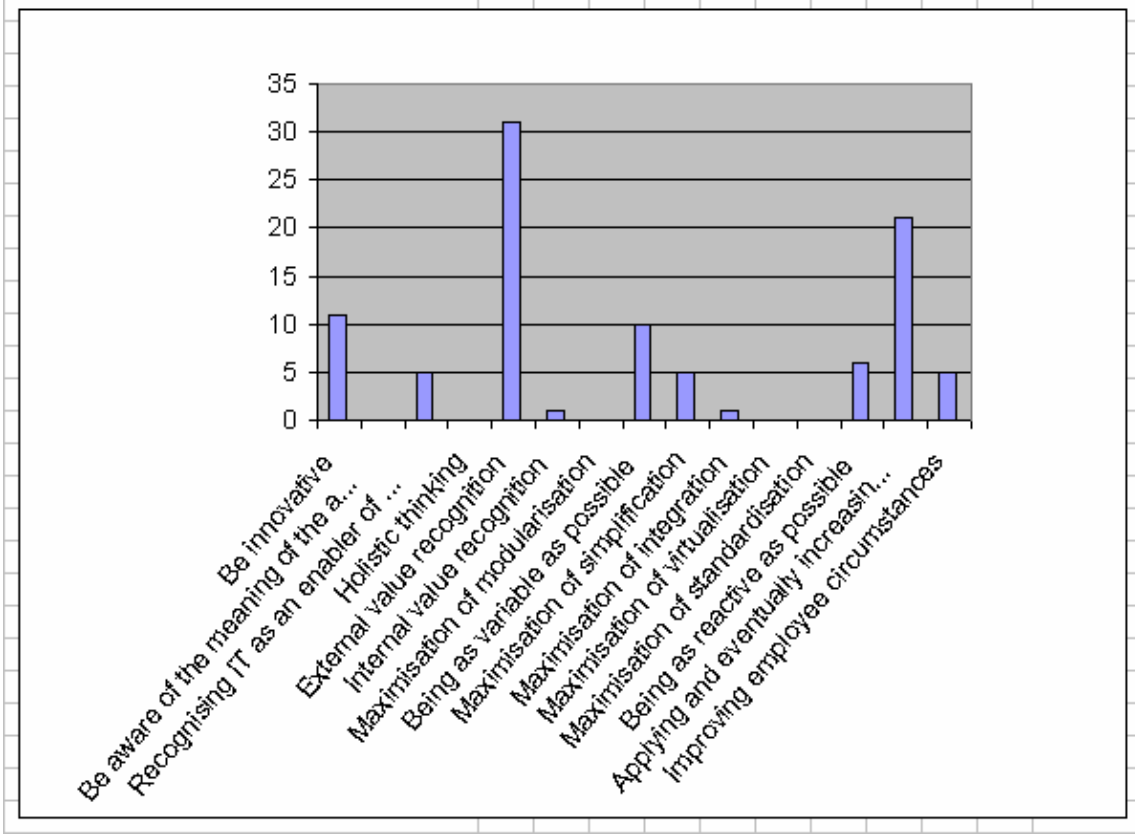
Results from question 5: Legislation

Principles/Respondent	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7	Company 8	Company 9	Totaal
Be innovative				5			1			6
Be aware of the meaning of the adaptive concept										0
Recognising IT as an enabler of adaptive capability						1				1
Holistic thinking			1							1
External value recognition										0
Internal value recognition										0
Maximisation of modularisation										0
Being as variable as possible		10		1	10		5			26
Maximisation of simplification		1								1
Maximisation of integration										0
Maximisation of virtualisation										0
Maximisation of standardisation			5			5				10
Being as reactive as possible					5	10	10			25
Applying and eventually increasing the number of close feedback loops		5		10						15
Improving employee circumstances			10							10



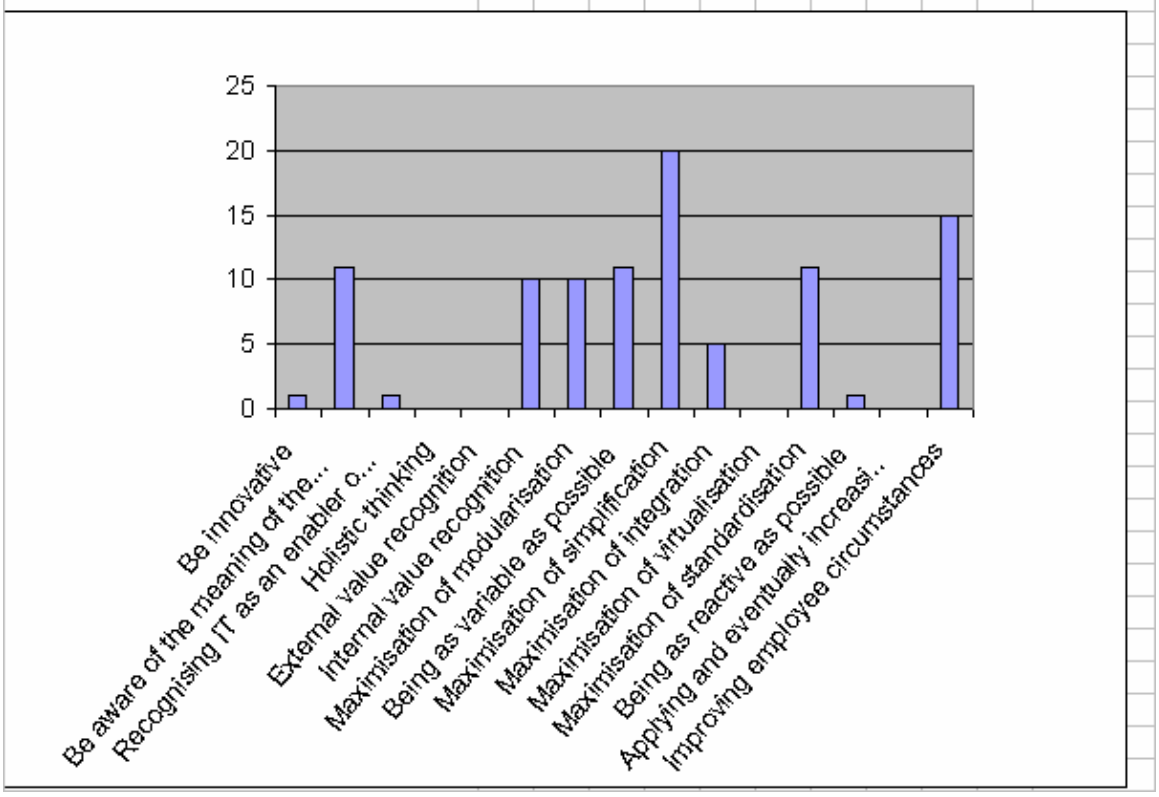
Results from question 5: Customer care

Principles/Respondent	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7	Company 8	Company 9	Totaal
Be innovative			10	1						11
Be aware of the meaning of the adaptive concept										0
Recognising IT as an enabler of adaptive capability		5								5
Holistic thinking										0
External value recognition		10		10	10		1			31
Internal value recognition			1							1
Maximisation of modularisation										0
Being as variable as possible			5		5					10
Maximisation of simplification							5			5
Maximisation of integration					1					1
Maximisation of virtualisation										0
Maximisation of standardisation										0
Being as reactive as possible				5		1				6
Applying and eventually increasing the number of close feedback loops		1				10	10			21
Improving employee circumstances						5				5



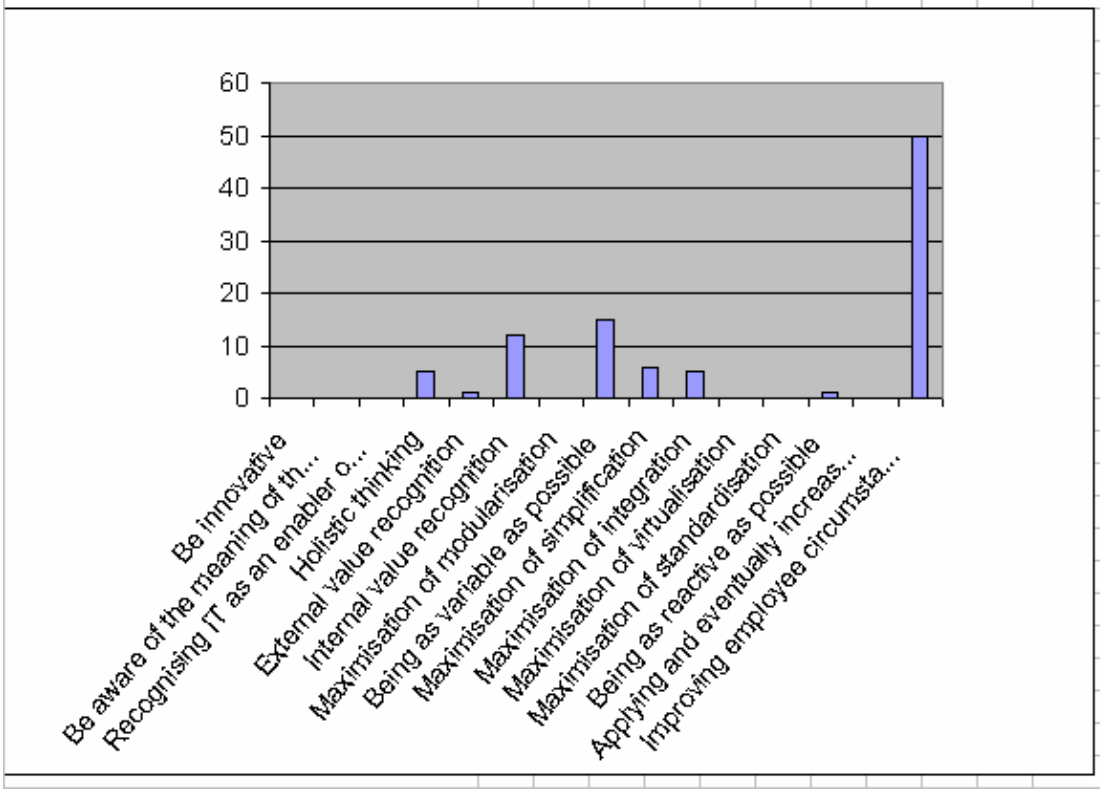
Results from question 5: Operational excellence

Principles/Respondent	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7	Company 8	Company 9	Totaal
Be innovative						1				1
Be aware of the meaning of the adaptive concept		10	1							11
Recognising IT as an enabler of adaptive capability					1					1
Holistic thinking										0
External value recognition										0
Internal value recognition				10						10
Maximisation of modularisation			10							10
Being as variable as possible				1	10					11
Maximisation of simplification		5				10	5			20
Maximisation of integration					5					5
Maximisation of virtualisation										0
Maximisation of standardisation		1	5			5				11
Being as reactive as possible					1					1
Applying and eventually increasing the number of close feedback loops										0
Improving employee circumstances				5			10			15



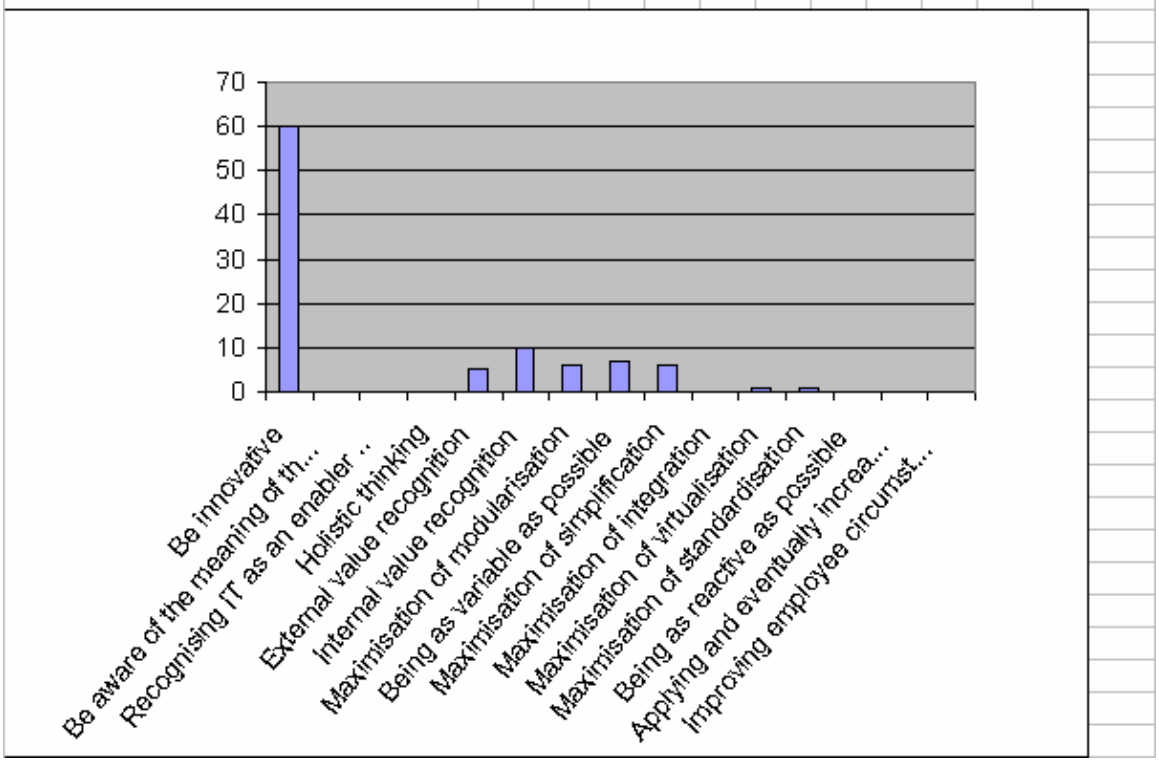
Results from question 5: Employee functioning

Principles/Respondent	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7	Company 8	Company 9	Totaal
Be innovative										0
Be aware of the meaning of the adaptive concept										0
Recognising IT as an enabler of adaptive capability										0
Holistic thinking			5							5
External value recognition		1								1
Internal value recognition		5		1		5	1			12
Maximisation of modularisation										0
Being as variable as possible				5	10					15
Maximisation of simplification						1	5			6
Maximisation of integration					5					5
Maximisation of virtualisation										0
Maximisation of standardisation										0
Being as reactive as possible					1					1
Applying and eventually increasing the number of close feedback loops										0
Improving employee circumstances		10	10	10		10	10			50



Results from question 5: Product innovation

Principles/Respondent	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7	Company 8	Company 9	Totaal
Be innovative		10	10	10	10	10	10			60
Be aware of the meaning of the adaptive concept										0
Recognising IT as an enabler of adaptive capability										0
Holistic thinking										0
External value recognition				5						5
Internal value recognition			5		5					10
Maximisation of modularisation						5	1			6
Being as variable as possible		5		1	1					7
Maximisation of simplification		1					5			6
Maximisation of integration										0
Maximisation of virtualisation						1				1
Maximisation of standardisation			1							1
Being as reactive as possible										0
Applying and eventually increasing the number of close feedback loops										0
Improving employee circumstances										0



Appendix B: Reflection

The goal of this research project was to identify the essential capabilities of an adaptive enterprise by formulating the most important architecture principles for such an enterprise. The process that has been undertaken to accomplish this goal has been extremely educational. Project activities like planning, formulating research questions and especially formulating interviews and conducting them has been extremely relevant for my personal development. Not just the *act* of interviewing was worthwhile, but also getting the opportunity to just change minds with professionals in the field that have already years of experience. To accomplish these tasks effectively requires a professional attitude that can only be gained through experience. I feel that I have made a good start in acquiring this experience.

Throughout the process of completing the project, several issues can be identified that I would carry out better in the future. The fact that merely 70 days were originally scheduled for the completion of the project, resulted in a very tight planning with only 5 weeks of literature study in the beginning. These 5 weeks were not enough for acquiring sufficient feeling with the topic, while simultaneously preparing for interviews.

Also, I would not recommend anyone to pursue other activities beside the completion of a master thesis research project. Performing thorough research requires a lot of time and energy, which does not allow for the execution of other activities. During the completion of the research, one has to be capable of accounting certain activities that can be a threat to the process. You have to be adaptive in a kind of way. This can only be done if you can concentrate with 100% on your research.

Glossary

Agility: The ability of an organization to respond quickly to demands or opportunities.

Artefacts: A part or a representation of a system or component. This component can be either made by humans or exist by nature. It may also not have been build yet.

Business intelligence
Business intelligence (BI) is a broad category of technologies that allows for gathering, storing, accessing and analysing data to help business users make better decisions.

Capability: the facility or potential for an indicated use or deployment. Merriam Webster

Collocation: Placement of equipment at common physical site to reduce environmental and financial impact and network deployment

Classification: the act of distributing things into classes or categories of the same type.

Digital architecture: is a coherent and consistent set of principles, particularised to guidelines, rules, and standards which describe how an enterprise, information services, applications and infrastructure are designed and demonstrated in use.

Enterprise architecture: An enterprise architecture prescibes the design of the components of an enterprise, their relationships and how they support the objectives of that enterprise by means of high level principles which are holistic and guiding.

ERP: (Enterprise Resource Planning) Software for running a business. ERP was coined as an extension of the concept of manufacturing resource planning (MRP) software, which automated the process of keeping a manufacturing line supplied with materials to meet incoming orders. ERP is a suite of applications including financials, manufacturing, human resources and other modules, that together automate the back-office business administration functions of an enterprise. Leading ERP vendors include SAP, Oracle, Peoplesoft and JD Edwards.

Ecosystem: A system involving the interactions between living organisms and the physical environment.

Framework: a basic conceptual structure.

Globalisation: Tendency toward a worldwide investment environment, and the integration of national capital markets. [BIZYAHOO]

Grid: A grid is a collection of distributed computing resources available over a network that appear to an end user or application as one large virtual computing system. A Grid can span locations, organisations, machine architectures, and software boundaries to provide unlimited power, collaboration, and information access to everyone connected to the Grid. The effect of Grid computing is to make network computing more like a utility.

Grid computing: A type of distributed computing in which a wide-ranging network connects multiple computers, whose resources can then be shared by all end-users; includes what is often called "peer-to-peer" computing.

Grid computing allows companies to deliver computing power where they need it, only when they need it; they pay for what they use, when they use it. Companies have the choice to build their own grid (in source it) or tap into one built by IBM (outsource it).

Guideline
A guidelines is less strict than rules or standards. The idea behind a guideline is, that it should be followed, because in many cases it will guide to (a route to) a good solution. Creativity or craftsmanship of the user of the guideline may lead him to deviate from it. A guideline can thus be simply formulated as being a *rule of thumb*.

Information age: A period of activity starting in the 1950s and continuing today in which the gathering, manipulation, classification, storage, and retrieval of information is central to the workings of society. Information is presented in various forms to a large population of the world through the use of machines, such as computers, facsimile machines, copiers, and CD-ROMs. The Information Age was enhanced by the development of the Internet; an electronic means to exchange information in short periods of time, often instantaneously.

Innovation: Introduction of a new idea into the marketplace in the form of a new product or service, or an improvement in organisation or process.

Invention: - a new and useful process, device, article of manufacture, or composition of matter, or new or useful improvement upon one of these.

Intelligent enterprise: An intelligent enterprise is able to transform itself into better and optimised forms by becoming intelligent [DEL&DAY03]. Intelligent is defined as: the ability to acquire and apply knowledge and skills [OXFORD].

LOB: Lines of Business

Outsourcing: A company chooses a consultant or application service provider to manage components of its internal IT structure, staff, processes and applications. This allows the organisation to remain focused on its business goals.

Principle: A principle expresses an idea, a message (culture / behaviour) or value that comes from corporate vision, strategies, and business drivers, experience or from knowledge of a subject and has a higher level of abstraction than prescriptions or requirements.

ROI: return on investment. In literature 'ROI' is also often used as an acronym for Return on IT, in this report however it is used as an acronym for return on investment.

Rules
In general, a rule is a prescription on how something has to be done. The aforementioned discussion suggests that a rule (in the narrow sense of the word) would be a prescription that has to be followed, but on which no agreement exists. Speaking of "in the narrow sense" doesn't clarify discussions. We think it will be clearer to speak of *prescriptions* for the broader sense of the word rule, and *rule* for the narrower sense.

SOA: (Service Oriented Architecture) A system for linking resources on demand. In an SOA, resources are made available to other participants in the network as independent

services that are accessed in a standardised way. This provides for more flexible loose coupling of resources than in traditional systems architectures.

SLA: (Service Level Agreement) Contractual service commitment. An SLA is a document that describes the minimum performance criteria a provider promises to meet while delivering a service. It typically also sets out the remedial action and any penalties that will take effect if performance falls below the promised standard. It is an essential component of the legal contract between a service consumer and the provider.

Standardisation: The development and implementation of concepts, doctrines, procedures and design to achieve and maintain the required levels of compatibility, interchangeability or commonality in the operational, procedural, materiel, technical and administrative field to attain interoperability [AMS].

Standard: A standard is used to facilitate the communication of an artefact with the outside world. XML can for example be seen as a standard to facilitate communication with other systems.

TCO: Total Cost of Ownership. A measure of the value of a product that factors in maintenance expenses as well as purchase price including hardware, software and services.
Utility computing: utility computing delivers computing power to companies as they need it, and only for as long as they need it—making it as reliable, affordable and easy to use as common utilities.

Virtualisation: is the ability to separate the direct dependency of an application to a physical resource.

Web-services: Automated resources accessed via the Internet. Web services are software-powered resources or functional components whose capabilities can be accessed at an internet URI. Standards-based web services use XML to interact with each other, which allows them to link up on demand using loose coupling.

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