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MASTER'S THESIS

THE IMPACT OF CLOUD COMPUTING ON ENTERPRISE ARCHITECTURE AND PROJECT SUCCESS

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MASTERS THESIS

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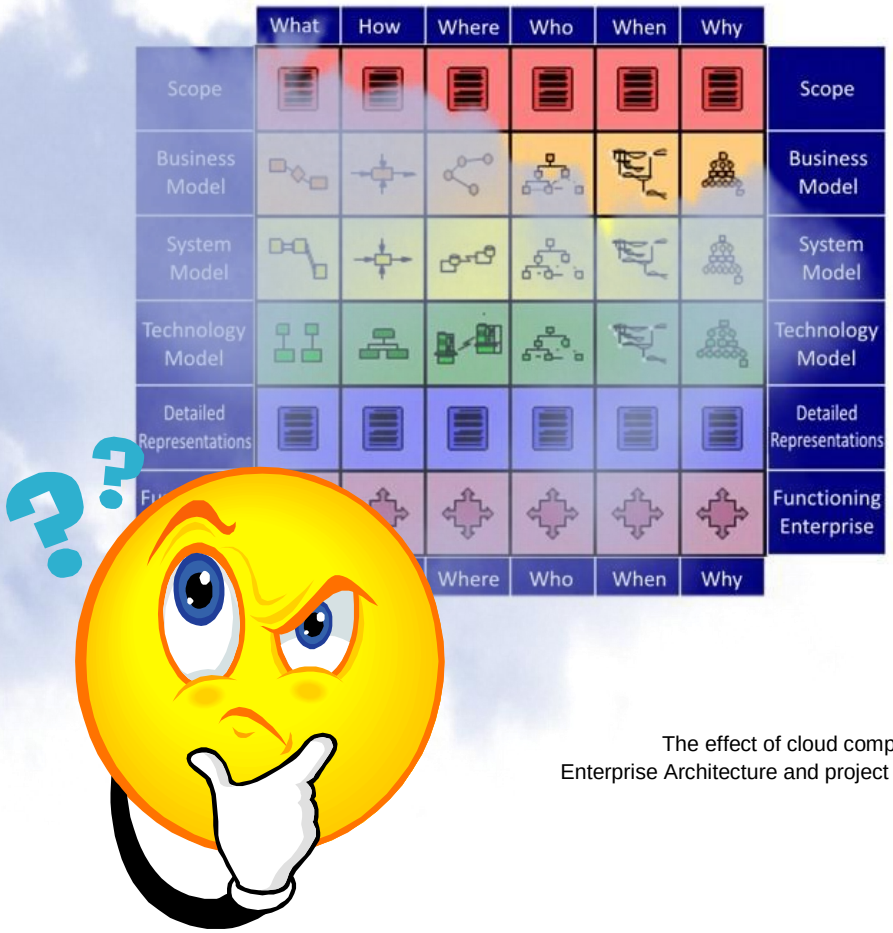

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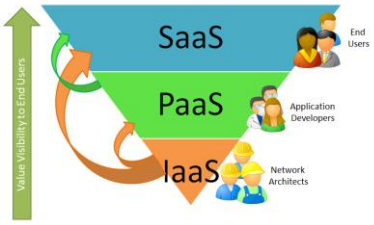
Table 2 distribution list

MANAGEMENT SUMMARY

SUBJECT

This thesis is focused on cloud computing and what the impact is on the enterprise architecture and projects success. Cloud computing is a way of offering services to a customer, it is based on a number of characteristics: on-demand self-service, broad network access, measured Service, resource pooling and rapid elasticity. These characteristics promise faster implementations times, lower cost, bigger scalability and more end user satisfaction.



Cloud computing can be delivered on several layers, the first layer is the Software As A service (SaaS) layer in which software applications are delivered, these services are mainly intended for end users. Below the SaaS layer the Platform As A Service (PAAS) layer is positioned this layer offers a platform on which applications can be developed. The lowest layer is the Infrastructure As A Service (IAAS) layer in this layer the physical servers and network infrastructure is offered as a service.

These services can be deployed throughout the public internet, then it is called a public cloud or throughout the internal infrastructure then the cloud is called a private cloud. Some combinations of these deployment styles are also available.

QUESTIONS

To provide an answer to companies that play with the idea of using cloud computing, but are discouraged by the feeling that there is little knowledge about the impact of this concept this study will assess the impact of Cloud computing on the architecture of an enterprise. One of the big promises of cloud computing next to cost and time to market is the implementation project result which will be better(Joint, 2009), due to a clearer view on the offered service and a shorter time to market. To validate if this promise results of the implementation's success are also investigated.

This resulted in the following research questions:

- What is the impact of the usage of cloud computing on the enterprise architecture?
- And what is the impact of these effects on project success?

RESEARCH APPROACH

To conduct this research first the theoretical model was developed based on the theory of cloud computing and enterprise architecture. Based on the model a validation was performed with expert interviews within several different organizations whom have adopted cloud computing in their core business processes. Based on these findings the impact of cloud computing on enterprise architecture for this context was described and substantiated with the found causes of the impact and effect to the business. Besides the impact the measured project success was compared between on premises (non cloud computing) and cloud computing implementations.

IMPACT OF CLOUD COMPUTING ON ENTERPRISE ARCHITECTURE

The first hypothesis was based on the thought that cloud computing does not change the way a company works but only facilitates the realization of the chosen strategy. Therefore the impact of cloud computing was expected in the realization layers of enterprise architecture.

Cloud computing impacts the operational layers in a enterprise architecture framework

This hypothesis was detailed in more depth with the use of the Zachman framework for enterprise architecture. The Zachman framework was chosen because it was the basis for many modern frameworks. Within the Zachman framework the following impacts where expected (green is no impact, and orange is complete impact).

	What	How	Where	Who	When	Why
Contextual						
Conceptual						
Logical						
Physical						

Table 3 Expected impact of cloud computing on the Zachman framework

In the validation phase of this research the impact was validated within 2 organizations which implemented a cloud solution for their core admission process. In order to dispose effects that are not accountable to cloud computing an organization who implemented this on premises solution for the same process was also investigated.

Based on the interviews the following impacts were found in the case of cloud computing (0 is no impact and 5 is complete impact)

	What	How	Where	Who	When	Why
Contextual	0	0	3,5	0	0	0
Conceptual	1,7	3	2	4	0	2
Logical	2,2	3,5	2,4	2,7	1,7	2,8
Physical	2,7	2,7	4,3	2,5	1,5	4

Table 4 impact of cloud computing on the Zachman framework

Based on these values we can conclude that cloud computing has mainly impact in the operational layers, starting at the logical level. Since an impact does not give the value of this impact to the business the interpretation of the impact was also investigated. This resulted in the following scores (where 5 is positive and 0 negative).

	What	How	Where	Who	When	Why
Contextual			5			
Conceptual	4	4,3	5	4		5
Logical	3,7	3,3	4,3	2,7	2,5	3,3
Physical	4	3,5	3	1	3	5

Table 5 Interpretation of the impact on the Zachman framework

Based on these values we can conclude that the impact of cloud computing to cells in the Zachman framework is there, and that the consequences of these impacts are positive to the business.

EFFECTS OF CLOUD COMPUTING ON PROJECT SUCCESS

Next to the impact of cloud computing to enterprise architecture, how cloud computing effects the project success was investigated. The implementation is said to be one of the big advantages of cloud computing(Joint, 2009). This hypothesis validates that promise.

Cloud computing results in a greater project success

Table 6 Hypotheses 2

To validate if this hypothesis is true the different aspects of project success according to the EFQM framework where used to compare project success results between on premises implementations and cloud implementation. The EFQM framework was chosen because the framework combines many other project success methods into one framework(Westerveld, 2003).

	Cloud	On premises
Time	4,2	2,5
Cost	4,3	1
Quality	4,3	3,5
Scope	4,6	4
Customer	4,4	4
Project members	4,3	3
Users	4,8	3,5
Partners	3,5	4
Stakeholders	4	
Total	4,2	3,2

Table 7 project success score of cloud computing versus a on premises

The biggest difference in scores is seen on the cost aspect cloud computing was rated a 4.3 where on premises got a 1 rating. Only the partner aspect was rated lower in the case of cloud computing, this

can be explained by the formal relations between the user and provider. In general one can say that cloud computing has a better score on project success aspects which means cloud computing has a higher project success in.

CONCLUSIONS

Based on the validation of the hypotheses the conclusion is made that cloud computing has impact on the implementation details of a strategy, but this impact bring a positive effect to the business. The implementation details start from the logical layer in the Zachman framework, and in project terms it constraints the solution design or requirements phase of a project. These constraints are mainly caused by limitations of the cloud service that was developed for multiple organizations which can limitedly be adjusted in terms of functionality or technical implementation.

Next to the positive effects, the implementation of a cloud solution has a better results in terms of project success which means the project and solution fit better to the organization and users. This is caused trough better insight in costs, functionality and implementation time and limited effects to the infrastructure of the user.

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1 INTRODUCTION

Cloud computing is currently in the interest, it is in the top quadrant of the Gartner hype cycle (Gartner, 2009) with regards to application architecture(see figure 1). As many organizations look to Gartner regarding trends, it is expected that Cloud computing will make its appearance in more organizations. However expectations are probably too high.

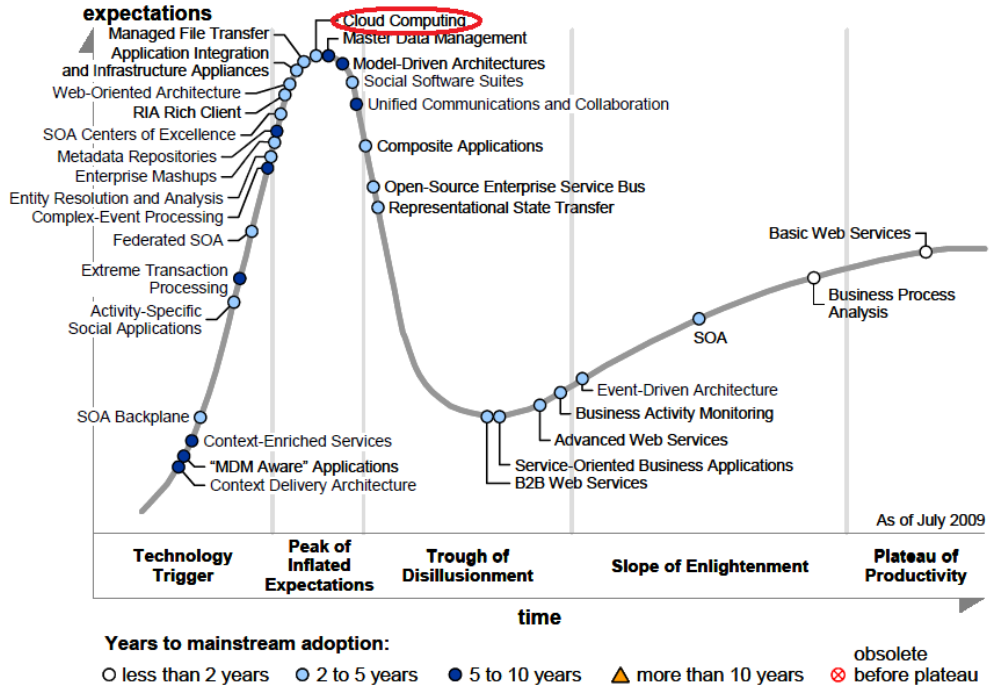

Figure 1 Hype Cycle for Application Architecture, 2009 (Gartner, 2009)

Cloud computing is about hiding complexity by using services from which are managed by someone else. This can be done at 3 different levels infrastructure, platform and software level. The cloud providers make their profit through economies of scale, the consumers on the other side pay less than what they did when they manage the service by themselves and they can scale their computing power when they need it.

Next to cloud computing enterprise architecture is a field of expertise which is getting more and more important because enterprises are getting more complex and have to deal with complicated legislation and rules which require to be flexible (Zachman, 1987). Enterprise architecture is an expertise area which organizes and designs an enterprise is such a manner that it is aligned with the business strategy.

This thesis investigates the impact of the utilization usage of cloud computing in enterprise architecture and how cloud computing relates to project success. With the results of this investigation, a substantiated decision on the use of cloud computing can be made.

1.1 RESEARCH PROBLEM

Currently, many organizations are interested in using cloud computing capabilities, but they do not know where to expect changes when choosing for the cloud computing concept (Joint, 2009). In practice, there are two distinct groups: one group tries to use cloud computing, and the other group is so discouraged by the stories in the media about security and availability that they ignore the phenomenon. This is also a conclusion found by a research done by Avanade: “the study presumes that the skepticism is due to unfamiliarity” (Avanade, 2009).

When it is more clear for organizations what the impact of cloud computing is, and how this could be tackled, organizations could make a more informed choice about using cloud computing for certain functionality (Heffner, 2010).

The problem is that the impact of cloud computing on the enterprise architecture is not clear for companies

Table 8 research problem

Next to the impact, a success rate of cloud computing implementations will influence organizations when choosing for cloud computing.

1.2 RESEARCH QUESTION

To provide an answer to companies that play with the idea of using cloud computing, but are discouraged by the feeling that there is little knowledge available about the impact. This study will assess the impact of Cloud computing on the architecture of an enterprise, which then assures the coherence of a function within an organizations design and construction. One of the big promises of cloud computing next to cost and time to market is the implementation result which will be better(Joint, 2009), due to a clearer view and a shorter time to market. To research if this promise is true the results of the implementation's success are also investigated.

What is the impact of the usage of cloud computing on the enterprise architecture? And what is the impact of these effects on project success?

Table 9 research question

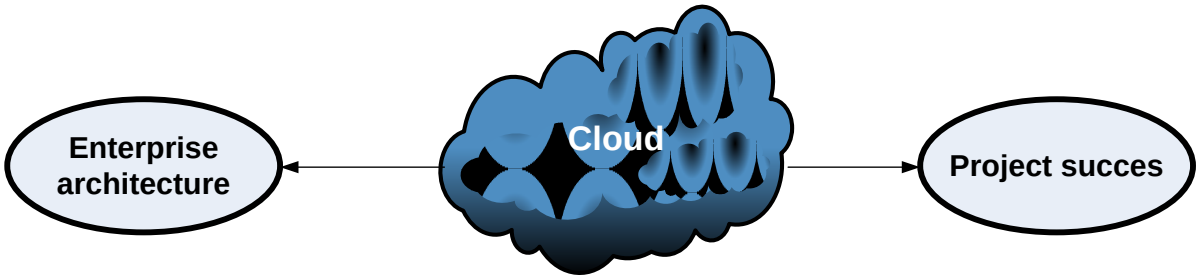

Figure 2 research question

For the research question, there are sub-questions defined that help to oversee the steps to achieve a similar answer to the research question.

The sub research questions are:

- What is enterprise architecture?
    - How can the impacts on the structured enterprise architecture be identified?
        - What is the Zachman framework?
- What is cloud computing?
- Which impact of cloud computing can be found on the enterprise architecture?
- How can project success be measured?

1.3 HYPOTHESES

Within this study, the impact of cloud computing on the enterprise architecture is investigated. Basically an enterprise architecture consists of the layers of business, which describes the business. The business layer is supported by data and data is supported, or maintained by an application. An application runs on certain technology (M. van den Berg, 2009). When one looks at cloud computing one can see also different layers namely SaaS, Paas and IaaS, details of these layers are elaborated in chapter 2.1.

In Figure 3 the cloud layers are mapped to the enterprise architecture layers.

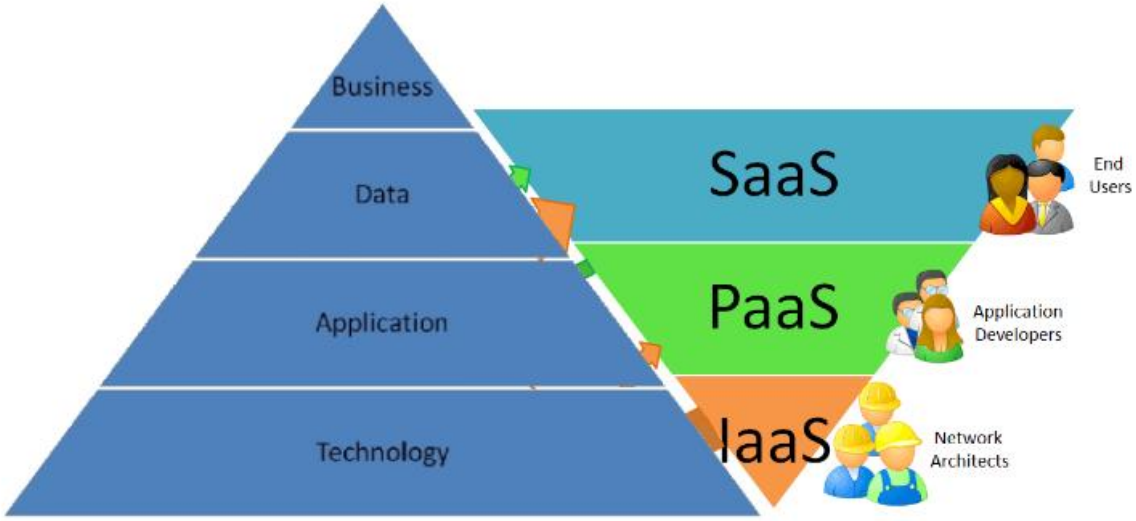

Figure 3 Enterprise architecture mapped to cloud computing

With this mapping in mind the expectation is that cloud computing impacts the realization layers of the business (from data to technology) in enterprise architecture. This is based on the conclusions made by Armbrust that cloud computing is a technology driver which supports the business and not influences it (Armbrust, et al., 2009). In chapter 5 the detailed expectations are elaborated further within a selected framework.

Cloud computing impacts the operational layers in an enterprise architecture framework

Table 10 Hypothesis 1

When cloud computing has big an impact in the upper layer (business) it would mean that the business adapts to the potential of ICT. This means that the company follows a technology strategy, possibly being aware of it (Venkatraman, 1993). This may consequently create a mismatch between the expected and the obtained functionality.

The expectation however is that the impact also occur in the data, application and technology-layers. In these layers the systems, modules and applications which are determined by the provider as to how they work. Also, a small part of the business layer are partly affected by providers. They offer

limited freedom in their services. They need to offer their services to multiple customers, allowing the precise tailoring of services cannot be realized.

The next hypothesis is based on one of the advantages of cloud computing that the implementation success which would be better due to a limited impact on the organization since the technical artifacts are outsourced (Skilton, 2010) (Joint, 2009).

Cloud computing results in a greater project success

Table 11 Hypothesis 2

1.4 RESEARCH STRUCTURE

To conduct this research first the theoretical model was developed based on the theory of cloud computing and the enterprise architecture. Next to the theory the model was expanded with exploratory case studies. Based on the model a validation was performed with help of 3 different organizations whom have adopted cloud computing in their core business processes.

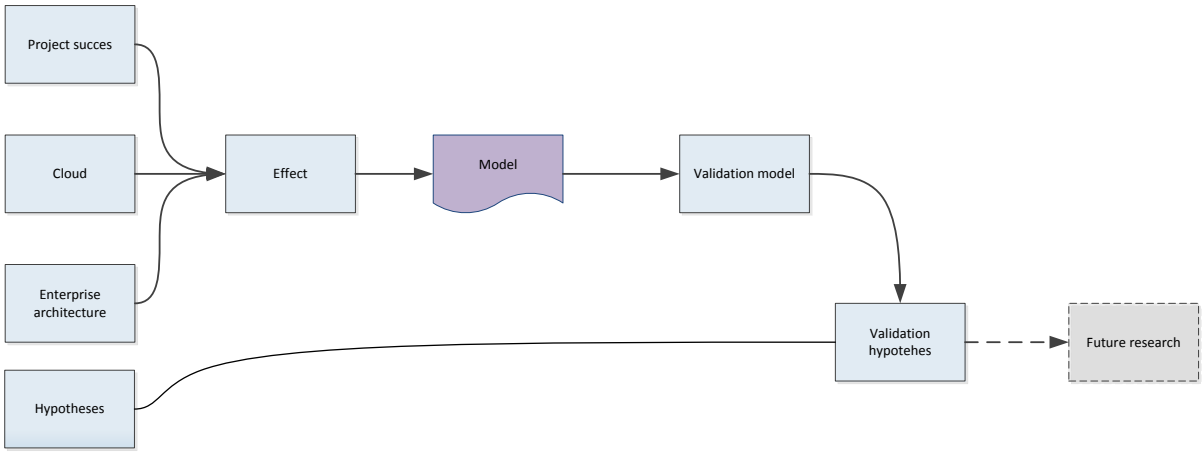

Figure 4 Research structure

In this report the theory on cloud computing is explained in chapter 2, in chapter 3 enterprise architecture and the Zachman framework are described together with the EFQM framework which is used to measure project success. Chapter 4 contains a summary of the findings in the literature and exploratory case studies.

This resulted in the model explained in chapter 5, and in chapter 6 is the practical validation of the model was shown. Based on these findings the hypotheses where answered and future research is suggested.

2 CLOUD COMPUTING

As mentioned in the introduction cloud computing is a big hype nowadays. It gives companies the power to react quickly to a growing demand of computing power, this creates agility for them. This is done by combining technologies such as virtualization, which makes it possible to separate application and platform logic from hardware, so that an application can run on different types of hardware without adapting to the application/platform. This makes it possible to deploy an environment very quickly. Next to virtualization, internet technology is responsible for a big part of the success since it makes it possible to use the service from anywhere and for any device.

Because cloud providers have huge data centers that they can spread their hardware among the different customers so called multitendency, this results in an optimum hardware usage which is called economies of scale. Because of this they can charge the customers only for the actual usage, this is called pay per use.

Although regarding the exact definition of Cloud Computing there are many opinions, below are the definitions of the NIST (National Institute of Standards and Technology) and the results from the research of Hand on cloud definitions.

> Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models. (NIST, 2009)

> Cloud Computing, in which not just our data but even our software resides within the Cloud, and we access everything not only through our PCs but also Cloud-friendly devices, such as smart phones, PDAs... the megacomputer enabled by virtualization and cloud computing...This is utility computing powered by massive utility data centers. (Hand, 2007)

As found in the definitions cloud computing comes in several different variants, these variants build on, on each other. The Hand definition is a definition which is clear for businesses, but the NIST definition will give more understanding for IT oriented people. In this paper we adopt the NIST definition and use some literature in the paragraphs below to sharpen the definition. In the first paragraph (Service models 2.1) the different service models are described, a service model describes what type of functions are provided. A service model can be offered in a type of deployment, and this is described in the paragraph 2.2. In the last paragraph (2.3) an overall conclusion is written about the definition of cloud computing.

2.1 SERVICE MODELS

In this paragraph the different service models of cloud computing are distilled. There are three different levels of services models. It starts from the lowest service model which is called Infrastructure As A Service (IAAS) and builds up via Platform As A Service (PAAS) to Software As A Service (SAAS). Each level adds extra functionality and abstraction of the technical details of the services which are offered.

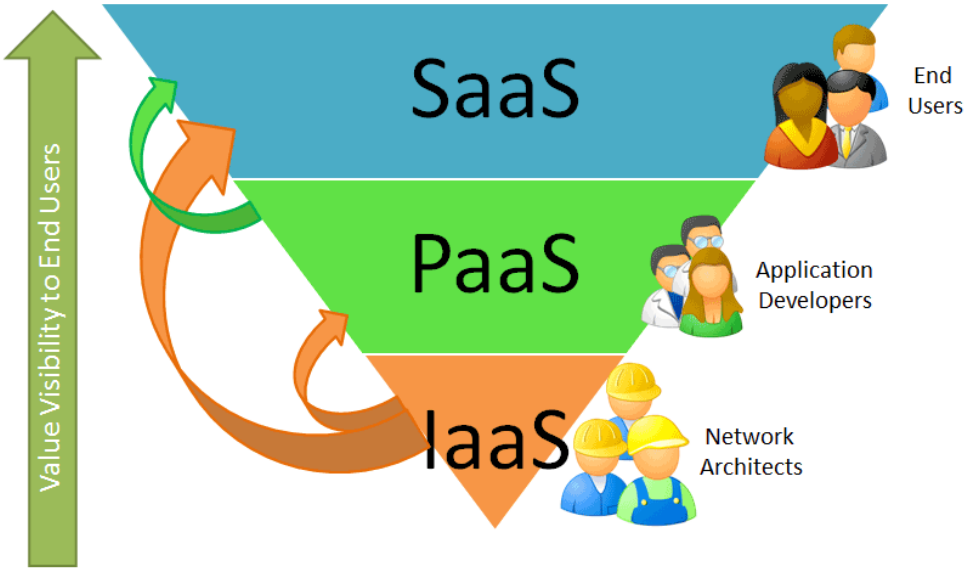

Figure 5 Cloud computing stack (Schuller, 2010)

As shown in Figure 5 the different levels provide their services to different types of users from network engineers to end users.

2.1.1 IAAS

Infrastructure as a Service (IaaS): is the lowest layer where users use computing resources such as databases, CPU power, memory and storage from an IaaS provider and use the resources to deploy and run their applications. In contrast to the PaaS model, the IaaS model allows users to access the underlying infrastructure through the use of virtual machines which automatically can scale up and down. IaaS gives users more flexibility than PaaS as it allows the user to deploy any software stack on top of the operating system. However, this flexibility comes with a cost and users are responsible for updating and patching the operating system at the IaaS level. Amazon Web Services' EC2 and S3 are popular IaaS examples(Murphy, Abraham, Fenn, & Goasguen, 2009).

2.1.2 PAAS

Platform as a Service (PaaS): is the layer where applications are developed using a set of programming languages and tools that are supported and provided by the PaaS provider. PaaS provides developers with a high level of abstraction that allows them to focus on developing their applications. Developers can provide their customers with a custom developed application without the hassle of defining and maintaining the infrastructure. Just like the SaaS model, users do not have control or access to the underlying infrastructure being used to host their applications at the PaaS level. Google App Engine and Microsoft Azure are popular PaaS examples(Boniface, et al., 2009).

2.1.3 SAAS

Software as a Service (SaaS): is a cloud computing layer where users simply make use of a web-browser to access software that others have developed, maintain and offer as a service over the web. At the SaaS level, users do not have control or access to the underlying platform and infrastructure that is being used to host the software. Salesforce's Customer Relationship Management and Google gmail are popular examples that use the SaaS model of cloud computing(Armbrust, et al., 2009).

2.2 DEPLOYMENT

The three different service models can be deployed for a customer in various ways varying from the public internet to a private data center. The Figure 6 shows the different deployment strategies (Joint, 2009) which are detailed in the following paragraphs.

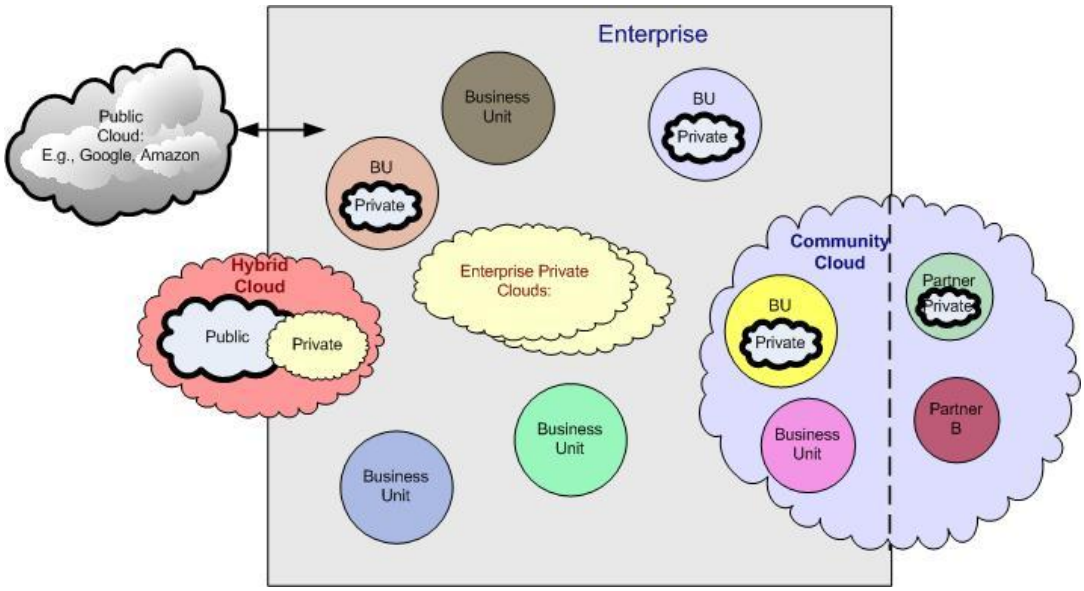

Figure 6 deployment models(Brown, 2009)

2.2.1 PUBLIC

Public is a deployment strategy which uses the publicly available internet to deliver the services to the users. A great advantage of this deployment type is that the services are available from any internet connection, an down side however is the security. The cloud services like Gmail and Azure are services provided trough the public cloud (Armbrust, et al., 2009).

2.2.2 PRIVATE

This deployment strategy can be compared with the traditional in-house hosting of a service, however it uses the technologies on which cloud computing is based such as virtualization to provide advantages to the organization(Armbrust, et al., 2009).

2.2.3 COMMUNITY

A community cloud is a bit like a private cloud however the cloud is shared among a community of organizations. This is done to divide the costs and risks of running a own cloud. These clouds can be found in shared service centers which service multiple organizations (Buyya, 2009).

2.2.4 HYBRID

A hybrid cloud is a cloud computing environment in which an organization provides and manages some resources in-house and has others provided externally. For example, an organization might use a public cloud service, such as Amazon's Elastic Compute Cloud (EC2) for general computing but store customer data within its own data center (Cole, 2009).

2.3 CONCLUSION

Based on the literature we can see three different service models which build on each other, they share though some characteristics: Agility, Multi-tenancy, scalability, pay as you go, any device, any location.

The lowest form of cloud computing can be found in the infrastructure as a service, in which a flexible and scalable infrastructure is offered at a pay per use price. Infrastructure can be defined as connections, CPU power and data storage.

The next level is Platform as a service in which much functionality is offered with the constraints of the selected technology. The offer consists of a development environment with extra services such as data connectivity and a development environment.

The third level is Software as a Service, this layer offers an complete standardized software application to the user.

Lately there are also thoughts on BPaaS Business Process as a service which offers the execution of a whole process as a service. This kind of service is also seen in the outsourcings world and is there known as Business Process Outsourcing (BPO) (Norta, 2009). In this research the BPO/BPaas subject is placed out of scope since it is not completely based on the characteristics such as virtualization and internet technology of cloud computing.

The different service models can be deployed in various ways, including a common practice is throughout the public internet, which is called the public cloud. Another form is deployed in a private data center in that form it is called private cloud, in-between these deployment models there an hybrid models available.

In this thesis we start with detecting impact at the SaaS service model, since it will impact the highest layers in enterprise architecture. Next to the start from the SaaS service model this thesis uses only the public deployment model, since it is the most used deployment model (Armbrust, et al., 2009).

3 ENTERPRISE ARCHITECTUUR

Enterprises are getting more complex by the day, as they have to deal with strong competition, much legislation and fast changing whishes from customers. All these factors have their impact on the functioning of an enterprise. One has to acquire a balance between the factors. The discipline that creates the balance between all these factors is called enterprise architecture.

The formal definition of enterprise architecture according to IEEE is:

> The Architecture (of a system) is the fundamental organization of that system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution. (IEEE, 2000)

According to the definition the architecture of a system (not only IT systems, an organization can be a system too) is organized using enterprise architecture. The architecture is responsible for all the components within a system and the relationship between them.

This means that enterprise architecture organizes the business which is supported by all related components and vice versa. In general a layered model is used to describe the enterprise architecture. In the figure below the most used layers are shown. Each enterprise architecture framework describes the fulfillment of the layers in detail, but in essence it can be plotted in the layers shown below(IEEE, 2000).

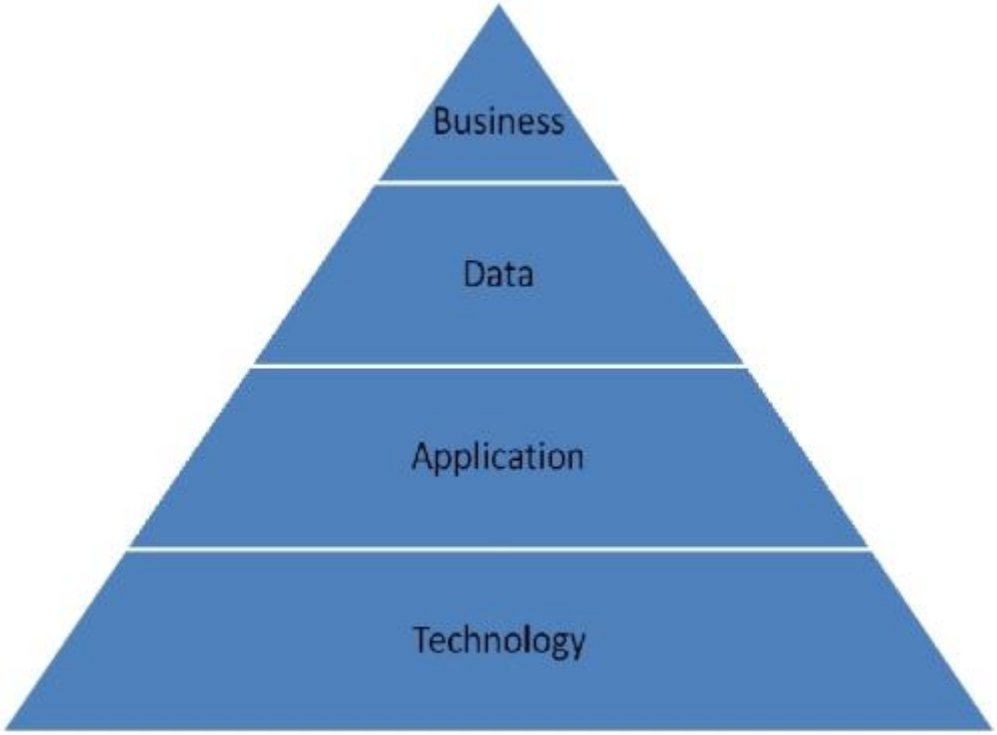

Figure 7 Enterprise architecture layers

Next to the definition of the IEEE there are many other definitions, which can be grouped into a classifications (views on enterprise architecture). In the paragraph below the way one can look at enterprise architecture is explained.

3.1.1 VIEWS ON ENTERPRISE ARCHITECTURE

There are two ways to streamline this balance one is from the regulations perspective. By selecting principles for business, information, data and technology an organization can steer the direction of the solutions to be implemented. Another way is the design way in which an architect creates a blueprint for the as-is and to-be organization. Based on this blueprint an implementer should realize the solution.

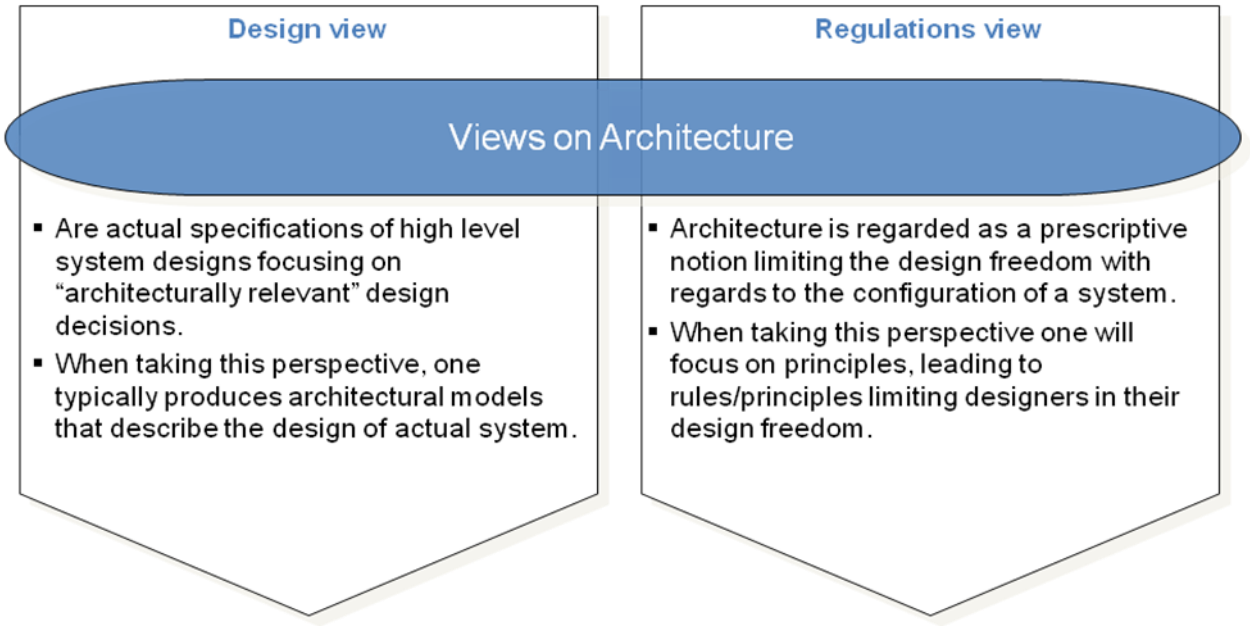

Figure 8 views on enterprise architecture (Gils, 2009)

Based on the definition of enterprise architecture there are many frameworks which help to describe enterprise architecture (design view). These frameworks guide the user in investigating each aspect of a architecture.

3.1.2 FRAMEWORKS

There are many frameworks such as IAF, TOGAF, DODAF. The basic idea behind a framework is to get a guidance in creating the enterprise architecture. A framework describes some views which help the user in obtaining the ultimate result. A view is a certain way to look at something, the desired view depends on the stakeholder. For example a business director would not understand a database model. Most frameworks start with the business need or vision and by filling certain views they end up in a working environment.

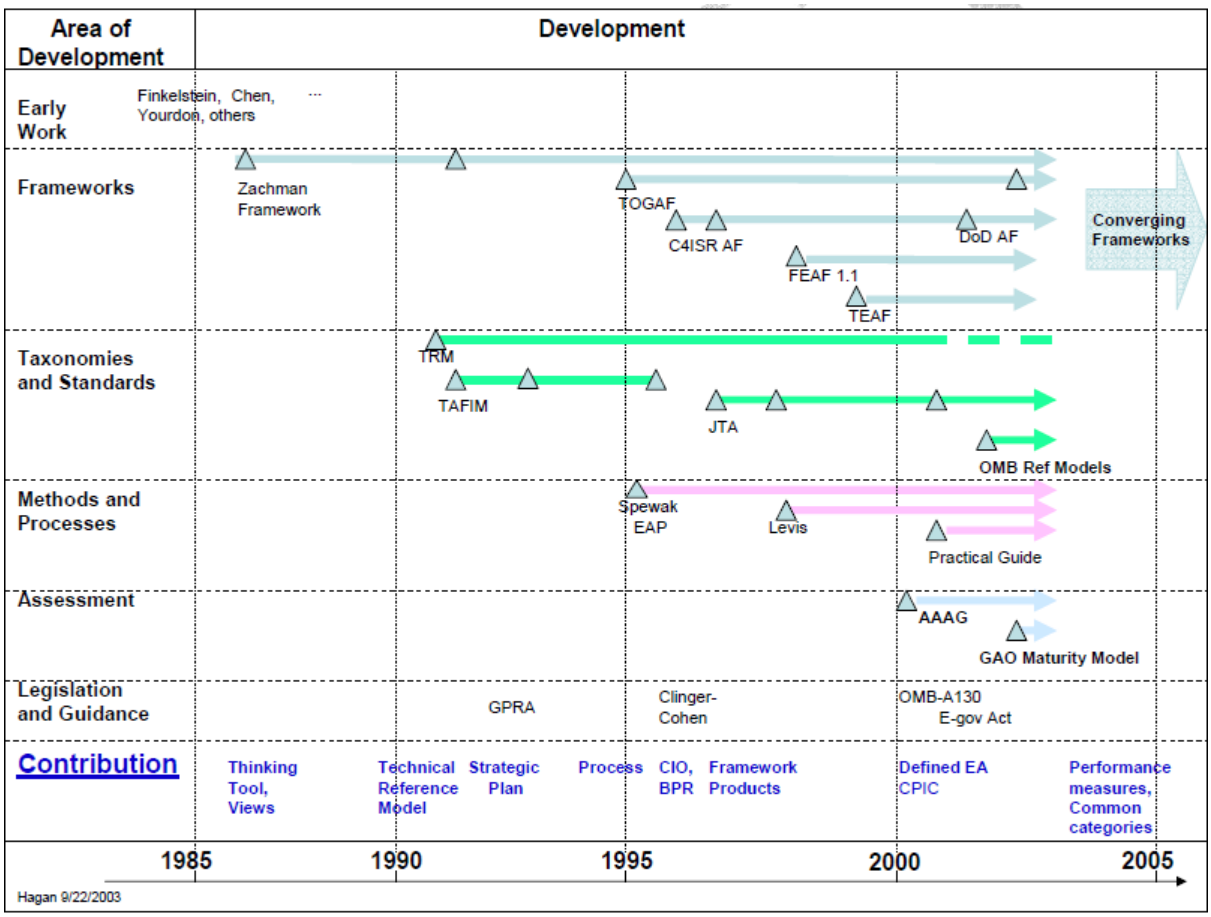

Figure 9 History of Enterprise architecture frameworks (McLean, 2004)

In this thesis the Zachman framework is used to position the impact of cloud computing. The Zachman framework is used because it forms the starting point for many modern frameworks, the framework of which is explained further below is mostly used in a design way of doing architecture. In Figure 9 History of Enterprise architecture frameworks (McLean, 2004) the history of enterprise architecture frameworks is plotted over time, this shows that the Zachman framework is the first enterprise architecture framework.

The mentioned taxonomies, standards, methods, processes, assessment and legislation guidance help filling the chosen framework, since it would not create extra layers or general elements these parts are not used in this thesis.

3.2 ZACHMAN

In the eighties of the 20th century John Zachman was confrontated with these effects and decides to develop a framework which helps organizing and rationalizing the architecture of a system. Zachman made a analogy with the construction of a building. With the construction of a building one needs an architect to develop a sketch of a building according to the wishes of a customer. Based on this chart the architect makes detailed charts for different “stakeholders” such as for an electrician or a bricklayer. Nowadays the Zachman framework is considered as the mother of many other frameworks such as TOGAF, DODAF, IAF (M. van den Berg, 2009)

Zachman used function names from the building world in his framework to make it more clear that building a information system is just like building an office tower.

The framework consists of 6 rows and 6 columns, the columns are about the questions on how, what where, who, when and why. At the crossing of a column with a row information is given on how the question for the column can be answered. So the intersection (cell) between why and contextual reasons why the organization wants, why does it stets himself the goal.

According to Zachman there are some rules for using the framework

- Rule 1 The columns have no order : The columns are interchangeable but cannot be reduced or created
- Rule 2 Each column has a simple generic model : Every column can have its own meta-model
- Rule 3 The basic model of each column must be unique: The basic model of each column, the relationship objects and the structure of it is unique. Each relationship object is interdependent but the representation objective is unique.
- Rule 4 Each row describes a distinct, unique perspective: Each row describes the view of a particular business group and is unique to it. All rows are usually present in most hierarchical organization.
- Rule 5 Each cell is unique: The combination of 2,3 & 4 must produce unique cells where each cell represents a particular case. Example: A2 represents business outputs as they represent what are to be eventually constructed.
- Rule 6 The composite or integration of all cell models in one row constitutes a complete model from the perspective of that row : For the same reason as for not adding rows and columns, changing the names may change the fundamental logical structure of the Framework.
- Rule 7 The logic is recursive : The logic is relational between two instances of the same entity.

The framework is generic in that it can be used to classify the descriptive representations of any physical object as well as conceptual objects such as enterprises. It is also recursive in that it can be used to analyze the architectural composition of itself. Although the framework will carry the relation

from one column to the other, it is still a fundamentally structural representation of the enterprise and not a flow representation.

Table 12 Rules of the Zachman framework(Zachman, 1987)

With these rules Zachman created a consisted framework in which relations between the different cells are forced but no redundancy will occur, this makes it possible to start filling the framework from the bottom or from the top. When this is done right cells are related to each other, which means the strategy of an organization is in line with its running systems. This is of course an ideal situation. In normal day to day routine organizations go from an “as is” to an “to be” situation and the framework is used to derive the needed change to reach to “to be” state. These changes could be found in the cells in which the relationship with other cells is disrupted or could not be found again.

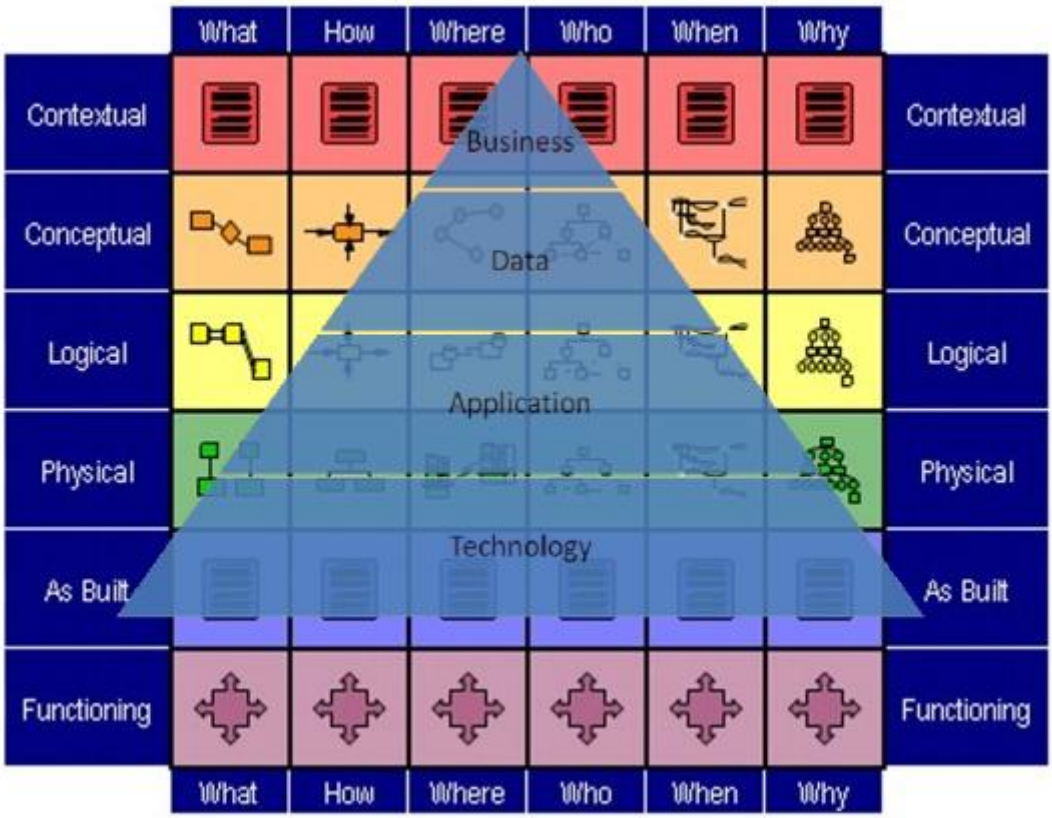

Figure 10 Zachman framework plotted to standard enterprise architecture(Zachman, 1987)

In the figure above the Zachman framework is shown within its plotted the basic layers of enterprise architecture as proposed in chapter 3. We see that the business and conceptual layers of Zachman consist of the business directions. In the conceptual and logical layers the needed information for these business directions are placed. In the logical and physical layers the mapping of these needs to an application is done. The layers below consist of the supporting technology.(Pereira & Sousa, 2004)

3.2.1 CONTEXTUAL

The top of the Zachman Framework describes the contextual layer, this layer is the highest layer and it contains an architectural sketch of the desired situation. This layer is called the planners layer

because it reflects only global information. What are the plans, how, where and by whom these plans are realized? What is it with realized and at what point does that happen, and why it is realized.

3.2.2 CONCEPTUAL

The conceptual layer is also called owner's layer, this layer provides more information on the operation of the strategy set in the contextual layer. With this description the owner determines whether the designs correspond to their wishes. In this layer mostly business models and process descriptions are used.

3.2.3 LOGICAL

The logical layer is further refined with the design elements and data flows. This refinement is needed to achieve the eventual realization. This layer is called the designers layer.

3.2.4 PHYSICAL

The physical layer, called builders layer also contains information on how the system should look like and what requirements it must meet. But it has an more technological goal

3.2.5 AS BUILT

In the as build layer the physical models are further broken down and their components are realized by developers or contractors.

3.2.6 FUNCTIONING

This system realized the lowest layer on top, this is an implementation of the above were made in the design.

3.3 CONCLUSION

In this chapter the definition of enterprise architecture is given, we see that the architecture of a system (not only IT systems, an organization can also be a system) is organized using enterprise architecture. The architecture takes care of all the components within a system and the relationship between them. Enterprise architecture can be viewed from a design and a regulations way. The regulations view is based on principles and the design view can be seen as a high level specification of a system. Within this thesis we use the design view.

Based on these choices and the history of frameworks the Zachman framework is selected to be used within this thesis. This framework is used to position the impacts of cloud computing in term of enterprise architecture.

4 MEASURING PROJECT SUCCESS

Organizations find it hard to define whether a project is successful, is it successful when a project is delivered within time and budget? Or is it successful when it realizes the business case? Or when the users are happy? The traditional time, cost and quality factors do not answer all these questions. To solve this question the European Foundation for Quality Management has developed a framework based on an extensive literature study in which project success can be measured and how it can be influenced by the project organization. This framework consists of the influences of many project management techniques, by combining all these techniques a new and complete framework was developed(Cooke-Davies, 2002).

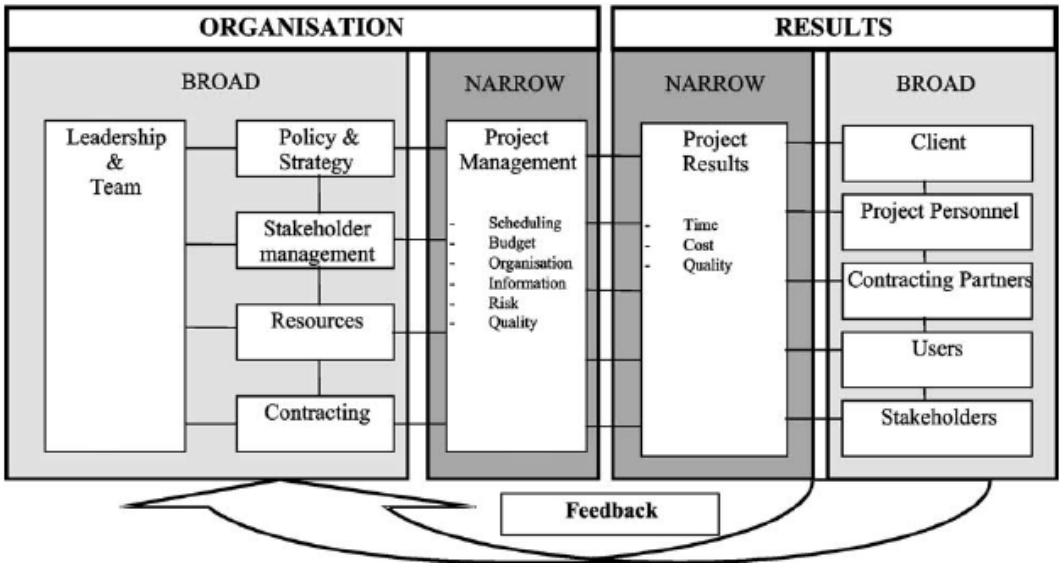

Figure 11: the project excellence model (Westerveld, 2003)

Within this thesis we use the way project results are measured to determine if a project is successful. Within the scope of this thesis the influence of a project organization on the success of cloud computing project is not taken into account. As shown in Figure 11 the results part consist of a few aspects:

Project results are measured in terms of time, costs, and quality, these aspects are the aspects which normally are managed within a project. These factors are called the devils triangle, which means you can influence 2 factors and you have to deal with the consequences of the third.

Next to the results **stakeholder** satisfaction is another big aspect of project success, when a user will not use a system so the system is built for northing. The model splits the stakeholder into groups. The client is the project owner, he initiated the project so, his/her satisfaction of the system is crucial. Within the project personnel is used to reach the result, they can influence the acceptance of the system. The users of the system need to be satisfied in order to get the system doing what it should do. Next to that partners such as external supplier are important for future support. And a category of other stakeholders which do not belong to the other groups.

Within this thesis we use the results aspects and let stakeholders from all groups rate the project on the different aspects. This will result into a score which is an average per organization which use cloud computing, this score will be compared to a similar project which did not use cloud computing.

5 THE IMPACT OF CLOUD COMPUTING ON ENTERPRISE ARCHITECTURE

Based on the literature the detailed impact was investigated and plotted to the Zachman framework, this impact is a refinement of the initial hypotheses of the impact of cloud computing . In chapter 1 the placed the hypotheses are laid down about the operational (data, application, technology) layers which are impacted by cloud computing. In chapter 4 there was decided to use the Zachman framework to plot the impact too, the figure below shows which cells cloud computing impacts in the Zachman framework (conceptual to as built). In essence one can say that the layer which determines what the mission and vision of an organization is, is not impacted, but only the realizations of the mission and vision can be limited or affected by the use of cloud services.

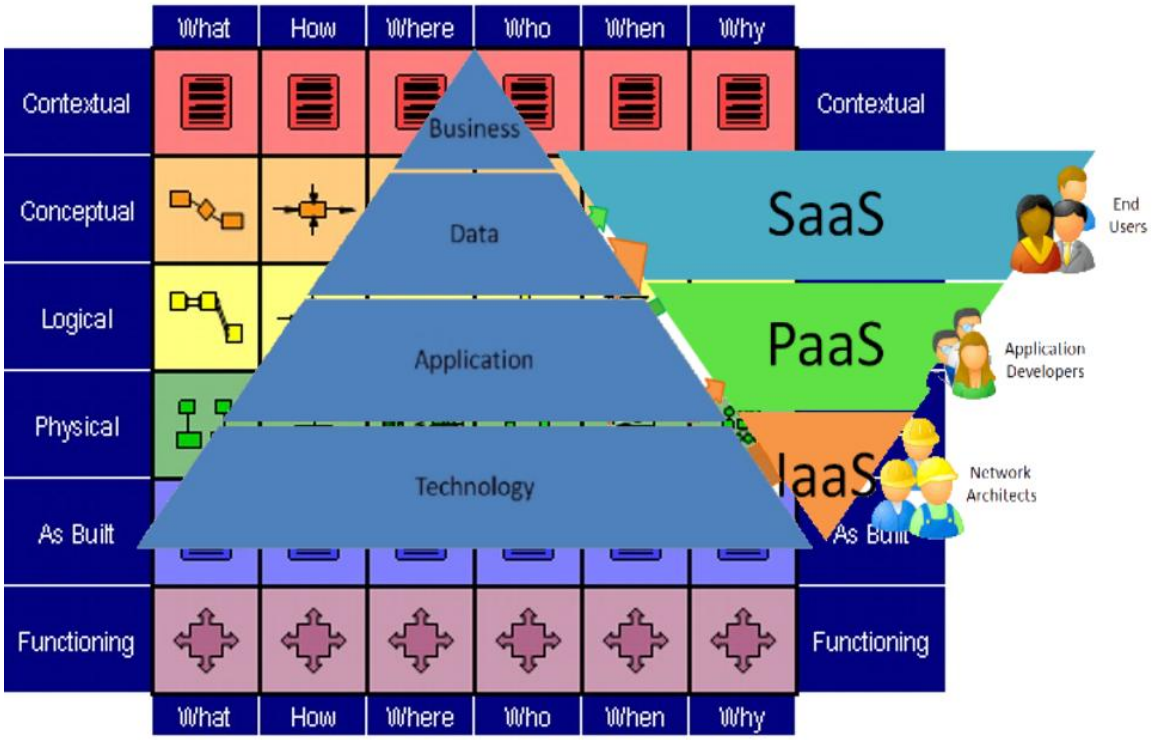

Figure 12 Hypotheses 1 mapped to Zachman

In the paragraphs below the impact per cell is explained and substantiated, this is done layer by layer starting from the top at the contextual layer.

A cell can be seen as impacted when the expected fulfilling of a cell is not reached from a business perspective. When a cell is partly impacted some details of the cell are differently implemented then was expected. An example of this is a small adjustment of screen to fit within the possibilities of the service. The function that directly is impacted, is defined as a cell for which the expected fulfillment needs to change in order to realize the cell. This is the case when a business wants a process to be completely automatics but the services do not support that.

Lately some startup organizations like jungle disk take advantage from the web and cloud technologies and grew big by the use of cloud computing, these companies are called web 2.0 companies. In the case of jungle disk they developed a online storage and backup tool, this was build

on cloud services Amazon and Rackspace (Broberg, Buyya, & Tari, 2009). Jungle disk grew in a small period of time (60 days) from a small number of users to a big organization with thousands of users using its services (Amazone, 2009).

Within this research we look at cloud computing for an existing organizational context (no web 2.0 companies), this means the organization has already existing structure which must be supported by services. For these companies cloud computing is not something that changes the whole business strategy, it is just an enabler when the strategy execution alignment process is followed (Venkatraman, 1993).

Web 2.0 organizations make use of cloud technologies and base their business strategy on these possibilities. The Jungle disk is the result of a company which uses the possibilities of cloud computing to start a company. These organizations do not have direct impact on cloud computing, they are influenced by the possibilities of cloud computing and determine the expected solutions on these possibilities.

5.1 CONTEXTUAL

Within the contextual layer limited impact is expected because of the level of details which is used in this layer. In the layer big organizational directions are chosen, cloud computing can mainly been seen as an enabler than a direction giver for most organizations(Leavitt, 2009).

In the paragraphs below the impact per cell is defined and secluded with a conclusion.

5.1.1 WHAT

> ” (What) Material List – list of all known organizational entities ”(Zachman, 1987)

In the “***what***” layer of the contextual row in the Zachman framework the entities that are considered important to the business, as viewed from each perspective are displayed. These entities are the things for which information is to be maintained. Examples include business objects and system data (Pereira & Sousa, 2004). At this level the effects of cloud computing can’t be found since it consists if high level data entities which support the (high level) business function.

5.1.2 HOW

> ” (How) Process List – list of all known processes”(Zachman, 1987)

In the “***how***” cell of the contextual layer in the Zachman framework the functions, processes, operations and activities that the enterprise is concerned about relative to each perspective. Inputs and outputs are also considered in this column. The basic thought how a company does his work won’t change but cloud computing reveals new opportunities to outsource a complete business process. So there seems no direct impact.

5.1.3 WHERE

> ” (Where) Geographical Locations List – locations important to organization; can be large and small”(Zachman, 1987)

With the use of internet technology one can leverage the business applications from any location which has an internet connection. The results in new ways of work in which an employee can perform their business task from home (Heerdt ter, 2008). On the other site the internet technology makes it possible to reach a completely new group of potential customers. So the usage of cloud computing can provide many opportunities to change the “***where***” cell in the contextual layer of the organization using it.

5.1.4 WHO

> ” (Who) Organizational Unit & Role List – list of all organization units, sub-units, and identified roles”(Zachman, 1987)

Tasks are performed by persons who play a role in an organization context. The expected roles in an organization will stay the same because of the fact that certain roles need to exist(Mintzberg, 1979) and a role requires specific knowledge to perform the required actions. So there is no impact at this contextual level for the "***who***" cell, since roles like production and management need to stay in order to keep the organization functioning.

5.1.5 WHEN

" (When) Event List – list of triggers and cycles important to organization"(Zachman, 1987)

The "***when***" cell on contextual level defines when or based on what event an organization makes a reaction or starts a process. This basic reactions won't be changed due to cloud computing, the way the triggers arrive at the companies can be changed, but that won't change the trigger itself.

5.1.6 WHY

" (Why) Goal List – primary high level organization goals"(Zachman, 1987)

The question "***why*** does an organization exist" is one in the essence of an organization this cannot be directly impacted by the use of cloud computing. An organization has to define what its purpose of existence is.

5.1.7 CONCLUSION

Overall one can conclude that the contextual layer of the Zachman framework isn't affected much. One can see that the internet technology offers possibilities to realize the work on other locations. But what, how, who, when and why an organization functions won't change due to cloud computing, since these factors make the organization what is it. This layer is mainly filled by the direction of an organization.

Row	impact
What	None, things that are important for the business stay the same
How	None, the high-level business process don't change
Where	Impacted, cloud computing can make it more flexible because of the use of internet functionality.
Who	None, the people needed by the organization will be the same. In case of business process outsourcing, which can be supported by cloud computing there will be a change because the people needed for a process won't be in the organization.
When	None, when a task is preformed needs to be the same in order to realize the aimed target
Why	None, the strategic direction of an organization is what the organization drives, this cannot be changed

Table 13 Contextual layer expectations

5.2 CONCEPTUAL

Based on the high level directions set out in the contextual layer more detailed goals are set in the conceptual layer, this level is mainly set out by business managers. In this layer some small impact in a few cells is expected.

5.2.1 WHAT

” (What) Entity Relationship Model – identifies and describes the organizational materials and their relationships”(Zachman, 1987)

This cell represents the “***what***” in conceptual view, it describes the relations between the things an organization uses and needs. At this level the impact of cloud computing can’t be found since it consists of high level data entities which support the (high level) business function.

5.2.2 HOW

” (How) Process Model – provides process descriptions, input processes, output processes”(Zachman, 1987)

In this cell the business process is described with its input and output(***how***). When an organization will use cloud computing its business process could be slightly adjusted because of the fact that the cloud services is designed for a generic purpose(Waters, 2005), this phenomenon is also familiar in the process standardization world, where they try to standardize business processes (Davenport, 2005).

5.2.3 WHERE

” (Where) Locations Model – identifies enterprise locations and the relationships between them”(Zachman, 1987)

The “***where***” cell in the conceptual layer changes because of the fact the ´***where*** “ cell in the contextual (higher) layer is also affected. With cloud computing organizations can run their functions all over the world.

5.2.4 WHO

” (Who) Organizational Unit & Role Relationship Model – identifies enterprise roles and units and the relationships between them”(Zachman, 1987)

The “***who***” cell in the conceptual layer does not change because of the expected roles to fulfills the tasks need to be the same. A person who manages the financial administration is still needed and the person needs the same knowledge.

5.2.5 WHEN

” (When) Event Model – identifies and describes events and cycles related by time”(Zachman, 1987)

When a company does its actions, for example buy’s his stock products is still a business choice. Cloud computing does not change this.

5.2.6 WHY

” (Why) Goal Relationship Model – identifies hierarchy of goals that support primary goals”(Zachman, 1987)

The business goals a company sets itself are distilled in the “***why***” cell on conceptual level. These goals need to be in line with its business strategy which can be found in the “***why***” cell on contextual level. In the case of cloud computing it will not adjust the strategy, it can only influence it (Ross, Weill, & Robertson, 2006) especially within out context of a strategy execution in Venkatraman terms (Venkatraman, 1993).

5.2.7 CONCLUSION

Based on the found literature one can say that cloud computing does not influence the conceptual layer. This sounds logical since the business goals are set in this layer, the only possible impact is in the how cell. This can happened due to complex organizational specific processes which need to be supported, but could not be realized with cloud services since these services must offer a standardized process which must fit in multiple organizations.

Row	Impact
What	None, relations between business entities need to be the same.
How	A business process could partly be affected because of the fact that cloud applications have a standardize process the support and the can be partly be adjusted.
Where	impacted, where the tasks are preformed can change due to cloud computing
Who	None, tasks and responsibilities should be assigned to personnel with similar competences
When	None, things need to be done at the same moment as they used to
Why	None, why a business does things don’t change with the usage of cloud computing

Table 14 Conceptual layer expectations

5.3 LOGICAL

The logical layer consists of the detailed processes, structures, and procedures which are set to realize the goals set in the conceptual layer. This layer is mainly filled by the personnel or their team leader which fulfills the expected tasks. This layer is partly impacted by cloud computing because of limitations of software. In the paragraphs below the impact per cell is defined and secluded with a conclusion.

5.3.1 WHAT

> ” (What) Data Model Diagram – identifies and describes entities and their relationships without regard to physical or technical implementation. ”(Zachman, 1987)

The “***what***” cell in the logical layer holds information of the data model. A data model for cloud solutions will not be the same as expected by the customer since the data model needs to be flexible to serve multiple businesses (F. Chong, 2006).

5.3.2 HOW

> ” (How) Process Diagram – identifies and describes process transitions expressed as verb-noun phrases without regard to physical or technical implementation. ”(Zachman, 1987)

In the conceptual layer the high level processes cloud be affected due to impossibilities with cloud services, since the Zachman framework builds on the available cells, this means this cell (***how***) is also affected(Nelson, Peterson, Rariden, & Sen, 2009).

5.3.3 WHERE

> ” (Where) Locations Diagram – identifies and describes locations used to access, manipulate, and transfer entities and processes without regard to physical or technical implementation”(Zachman, 1987)

The “***where”*** cell in logical level consists of the locations used to access the service, since the work can be done on different locations as described in contextual and conceptual level, the access to the systems should be available on different locations. By the usage of internet technology a service can be delivered to any place with internet connection.

5.3.4 WHO

> ” (Who) Role Relationship Diagram – identifies and describes roles and their relations to other roles by types of deliverables without regard to physical or technical implementation”(Zachman, 1987)

The “***who***” cell in logical level describes the which role fulfills which function. Since the needed roles within the organization stay the same in the contextual en conceptual level the relations between the roles and the deliverables stay the same.

5.3.5 WHEN

” (When) Event Diagram – identifies and describes events related to each other in sequence, cycles occur within and between events, without regard to physical or technical implementation ”(Zachman, 1987)

How the system events relate to each other is described in the “***when***“ cell in logical level. The cloud providers provide a process model for its service which can be adjusted a bit, but is generally does not have the ability to create new events or cycles(Nelson, et al., 2009).

5.3.6 WHY

” (Why) Rules Diagram – identifies and describes rules that apply constraints to processes and entities without regard to physical or technical implementation” (Zachman, 1987)

The rules an organization has implemented in a services are placed in the “***why***“ cell on logical level. Most cloud services offer possibilities to modify the business rules in the service to some extent, this mean not all rules can be realized by the service (Nelson, et al., 2009).

5.3.7 CONCLUSION

In the logical layer the first big impacted is expected, this is in line with the expected fulfillment of the cells. In this layer the service or application specific demands are distilled, since cloud computing offers a standardized solution we expect a mismatch between the business wish and the service possibilities. Due to the growing attention for Business process management and business rules management which make it possible to run processes or rules which are easily adjustable, because of these developments the how and why cells will be partly affected.

Row	Impact
What	The logical data model is partly effected because the solution must be flexible to support multiple businesses
How	How functions are preformed in details, is largely determined by the cloud provider
Where	How the functions are deployed over different systems is determined by the cloud provider
Who	How the functions looks like and who have rights to do certain things is partly affected to the use of cloud computing
When	The processing structure is mainly determined by the cloud provider
Why	Business rules can partly be changed in a cloud system

Table 15 Logical layer expectations

5.4 PHYSICAL

In the physical layer the logical information is enriched with details to which are needed to describe functional how the tasks should be supported. This layer is mainly filled by functional designers or process architects. This layer is impacted in several cells because of limitations by technology. In the paragraphs below the impact per cell is defined and secluded with a conclusion.

5.4.1 WHAT

> ” (What) Data Entity Specification – expressed in a technology specific format; each entity is defined by name, description, and attributes; shows relationships” (Zachman, 1987)

How the logical data model is represented in technology which is determined in the “***what***” cell in physical level, this technology model is not adjustable by the cloud users. The logical data model is usually distilled in a technical model which offers more flexibility to the cloud provider to serve multiple customers (F. Chong, 2006). But these technical models make it difficult to make distinctions per user, so the users do not see this flexibility.

5.4.2 HOW

> ” (How) Process Function Specification – expressed in a technology specific language, hierarchical process elements are related by process calls” (Zachman, 1987)

The way the logical process is realized within a technology model, is distilled in the “***how***” cell in physical layer. Since the logical level is partly affected by impossibilities the technology level will be affected by more impossibilities which occur by the use of models like BPMN (Davenport, 2005).

5.4.3 WHERE

> ” (Where) Location Specification – expresses the physical infrastructure components and their connections ”(Zachman, 1987)

Where the technical infrastructure is and how it works is described in the where cell of the physical level. The technical infrastructure is invisible for the end user since it is managed by the cloud provider. The only infrastructure a customer needs is an internet connection and the browser.

5.4.4 WHO

> ” (Who) Role Specification – expresses roles performing work and workflow components at the work product detailed specification level” (Zachman, 1987)

The “***who***“ cell in the physical layer shows the supported role by the service and the tasks a role can perform is distilled. The roles a service supports is somewhere limited by the design that is why not all roles of the customer can by implemented in the technology model.(Nelson, et al., 2009)

5.4.5 WHEN

” (When) Event Specification – expresses transformations of event states of interest to the enterprise” (Zachman, 1987)

The “***when***“ cell in the physical layer consist of the way events are transformed into business events. This is a technical action which is designed by the cloud provider, this results in a standardized solution, where the users don’t have any influence.

5.4.6 WHY

” (Why) Rules Specification – expressed in a formal language; consists of rule name and structured logic to specify and test rule state” (Zachman, 1987)

In the “***why***“ cell in physical level the implementation of business rules in a certain syntax is distilled. Since some business rules are not possible on logical level, these impossibilities still remain impossible at physical level.

5.4.7 CONCLUSION

The physical layer consists of the technological aspects of the to realize solution. Cloud provider need to standardize there solutions to serve multiple customers, this means many whishes of customers could not be realized by the standardized solution. Things like processes, rules and roles use technologies which are at a mature stage (Rosca & Wild, 2002) which offer a way to easily logically change the aspects without changing the code. Due to this abstraction these cells are only partly affected.

Row	Impact
What	The data model of the system is maintained by the cloud provider and only little adjustments are possible
How	How the system is designed, is the responsibility of the cloud provider, but some flexible solutions are offered
Where	How the infrastructure is build is designed by the cloud provider
Who	The supported roles of the services are determined by the cloud provider
When	How technical events are handled by the solution the determined by the provider
Why	The solution has some standardized system rules, but some cloud solutions provide functionality to dynamically change some rules of the system.

Table 16 Physical layer expectations

5.5 CONCLUSION

Based on the found impact in literature we conclude that the impact is mainly visible starting from the logical layer. This can be explained because the service support of business things starts at the logical layer. The layers above provider a more generic goal which can be implemented in several ways. The column where shows however a surprising but expected value, it is completely impacted, this has to do with the internet technology which makes it possible to use the offered services from all over the world.

	What	How	Where	Who	When	Why
Contextual						
Conceptual						
Logical						
Physical						
As Built						
Functioning						

Table 17 Zachman framework filled with expectations

Legenda
No direct impact
Partly impacted
impacted

Table 18 Legenda for Table 17

6 THE EFFECT OF CLOUD COMPUTING ON PROJECT SUCCESS

As mentioned in the hypothesis 2 (see paragraph 1.3) we expect that cloud computing will result in a overall better score on project success. This hypothesis will be substantiated in per EFQM aspect.

6.1.1 TIME

Implementation time is perceived as a big advantage in cloud computing according to (Waters, 2005). This is the result of the standardized environment which can be accessed through out an internet connection.

6.1.2 SCOPE

When you use cloud computing the result of what is being offered is available to try for stakeholders, this will result into a better view on what is offered. This will result in a better weighted scope. The implementation of cloud computing is very small, it consists usually of data migration, user management and providing the users with the needed URL. Traditional on premises implementations affect internal infrastructures too.

These factors will give cloud computing a clearer scope, which will result into a better score of the different stakeholders.

6.1.3 COST

The cost of the usage of cloud computing is clear at start and will only grow when the service is used more. On premises services need a big start budget to get implemented, which is not linked with the usage. This results in the expectation that the cost aspect of cloud computing will be rated better compared to an on premises situation.

6.1.4 QUALITY

Cloud services are shared among different organizations which means it is tested in different contexts. This will result in a better tested system for cloud services compared to on premises services.

6.1.5 SATISFACTION

Because of the clear view on what is offered we expect that the satisfaction of the different stakeholders (users, customer, project members and partners) will be higher, then with traditional on premises situations.

6.2 CONCLUSION

As described in the paragraphs above, cloud computing will provide clear advantages which will result into a better project success. In the table below the different aspects are summarized into a table which shows the effect to project success.

	Score
Time	
Cost	
Quality	
Scope	
Customer	
Project members	
Users	
Partners	
Stakeholders	
Total	

Table 19 expectation per project success aspect

Legenda
Positive
Neutral
Negative
No effect

Table 20 Legenda for Table 19

7 VALIDATION OF THE IMPACT

Based on the Zachman cells a questionnaire was developed which can be found as an addendum in chapter 11.1. Since the Zachman framework consists of many aspects of business, information and technology the questionnaire was divided amongst different roles, so the questions could be answered from the right perspective (role of the questioned person versus Zachman layer).

The following roles where questioned:

Role	Layers
Business director	Contextual, conceptual
business manager	Contextual, conceptual, logical
Functional IT staff	logical, physical
technical IT staff	physical , as build
Maintaince staff	as build, functioning

Table 21 mapping between roles and Zachman layers

The questions for the cells which are mapped to a role which should hold the knowledge to answer the questions. The basic question consist of impact of the fulfillment of a cell. When there was impact a question will be asked to discover the reason for the impact. Besides the reason for the impact also the interpretation of the impact was asked in terms of positive or negative from the perspective from the interviewed person. This approach resulted into 6 respondents per question and within total 12 respondents.

7.1 CONTEXT

The interviews are held in 2 organizations which implemented a cloud based solution for their core admission process and an organization which used a standardized solution on premises for the same admission process. Due to privacy reasons the names of the organizations are held private.

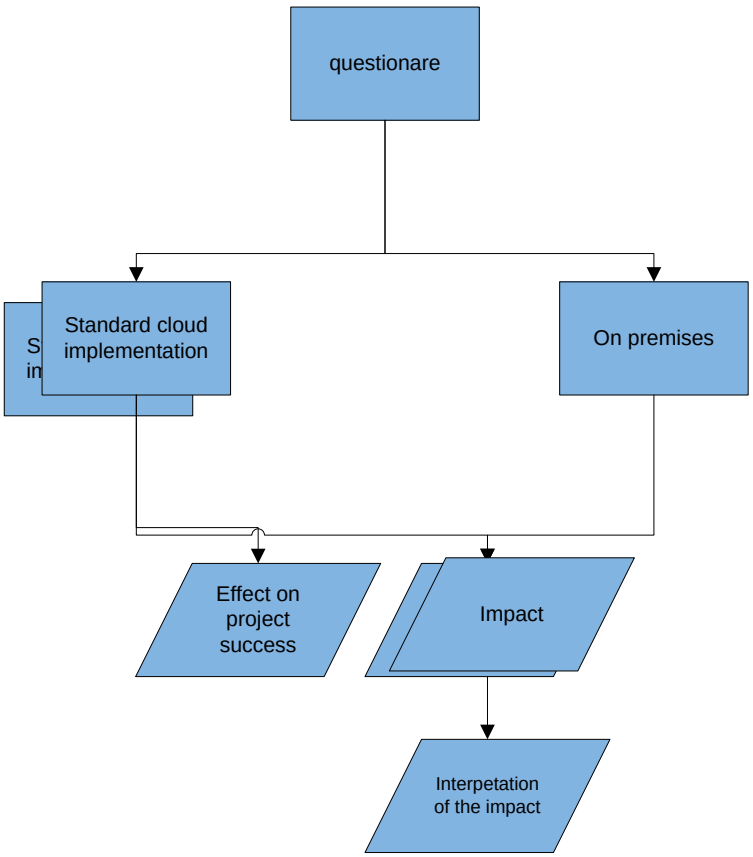

Figure 13 different context for questionnaire

These organizations are in term of the enterprise architecture as a strategy maturity framework on the 1st and lowest level “business silos architecture” (Ross, et al., 2006)

7.2 RESULTS VALIDATION

In the paragraph below the total scores of the impact are placed in the Zachman framework, in the paragraphs 7.2.2 and 7.2.2.1 a distinction between the scores for in the cloud and on premises implementations are made. The scores are an average score of the involved respondents, in the thesis the number of respondents were 6 per implementation type spread over different organizations. Next to the impact the interpretation per impact is shown in total and per implementation type (on premises vs. cloud) the detailed explanations per layer are described in paragraphs 7.3 to 7.6. As mentioned in the hypothesis the as build and functioning layers are not researched, therefore these layers are left out of the tables below.

7.2.1 IMPACT

Based on the results of the questionnaire the following impact is detected in practice. Per cell a value is shown which gives the impact, a "-" is no score which means no impact. The value 5 is the highest impact a cell can have, this is when the fulfillment of the cell is completely different for the realized situation. The scores represent an average of all the respondents for the question, in the case of broadly spread answers, a note in the conclusions is made.

The table below shows the total score from organizations with and without cloud, in the paragraphs below the results per implementation type(cloud and on premises) is shown.

	What	How	Where	Who	When	Why
Contextual	-	0,3	2,3	-	0	0
Conceptual	1,4	2,6	1,6	3,2	0	1,0
Logical	2,7	2,5	1,9	1,8	2,5	3,2
Physical	2,7	2,3	3,8	2,0	1,3	3,3

Table 22 overal result

Legenda	
No direct impact	< 1,0
Partly impacted	>1,0 <3,0
Impacted	>3,0

Table 23 Legenda for Table 22

In the chapter before we distinct impacted and partly impacted cells, within the validation we used scores from 0 to 5 to detail the impact. Therefore a mapping between impacted and partly impacted to a score is made. A cell is not impacted when a score below 1,0 is rated, partly impacted is from a score of 1,0 to 3,0 and impacted cells have a score higher than 3,0.

In general one can say that the lower Zachman layers have the most impact, this is conform the expectation as proposed in the hypotheses. In the paragraphs (7.3 to7.6) below the results per layer are shown, and plotted against the expectation and explained.

7.2.2 CLOUD IMPLEMENTATION

The impact between a cloud implementation and an on premises implementation were split, the table below shows the scores from the organizations which used cloud computing to realize their implementation.

	What	How	Where	Who	When	Why
Contextual	0	0	3,5	0	0	0
Conceptual	1,7	3	2	4	0	2
Logical	2,2	3,5	2,4	2,7	1,7	2,8
Physical	2,7	2,7	4,3	2,5	1,5	4

Table 24 results from organizations with a cloud implementation

In general one can say that cloud computing has a higher impact score on the most cells than the merged score, which means that cloud computing has a bigger impact than a on premises implementation. As reported the details explanations and comparisons are made per layer in the paragraphs 7.3 to 7.6.

7.2.2.1 ON PREMISES IMPLEMENTATION

The impact between a cloud implementation and an on premises implementation were split, the table below shows the scores from the organizations which used on premises solutions to realize their implementation.

	What	How	Where	Who	When	Why
Contextual	0	1	0	0	0	0
Conceptual	1	2	1	2	0	0
Logical	5	0,5	0,5	0,5	0,5	4
Physical	1	1	2	1	1	2

Table 25 results from organizations with a on premises implementation

The scores show in overall low scores which means the solution matches the expectation of the organization. Although there are some high scores in the logical layer, these score will be explained in the following paragraphs.

7.2.3 INTERPETATION OF THE IMPACT

Since not every impact is negative, there was also research done on the interpretation of the impact. For every impacted cell in the Zachman framework the interpretation of the business was measured. The measured scores are plotted below in the framework. When a cell had no impact there was also no interpretation for the business, which resulted in an empty (white) cell.

	What	How	Where	Who	When	Why
Contextual		4	5			
Conceptual	4	4	4,7	4		
Logical	3,5	3,2	4	2,8	2,5	2,8
Physical	3,7	3,3	3	1,5	2	3

Table 26 Overal effect of cloud computing

Legenda
Positive effect
Neutral
Negative effect
No effect

Table 27 Legenda for Table 26

What strikes the most is that impact in the higher Zachman layers had a positive interpretation for the business. This has probably to do with new possibilities cloud computing offers to the business. The impact in the lower layers have a more negative interpretation to the business, this can be explained because the business wish is clear in the higher layers, but could not be realized due to technical impossibilities.

7.2.3.1 CLOUD IMPLEMENTATION

The table below shows the interpretation of an impact of cloud computing to the business.

	What	How	Where	Who	When	Why
Contextual			5			
Conceptual	4	4,3	5	4		5
Logical	3,7	3,3	4,3	2,7	2,5	3,3
Physical	4	3,5	3	1	3	5

Table 28 Interpretation of a cloud implementation

In the table above we see that the where cell is rated very positive by the business. The where cell is where business processes take place, in case of cloud computing new locations could be used to work, for example at home which could lead to better results. In the paragraphs 7.3 to 7.6 the scores per layer are detailed further.

7.2.3.2 ON PREMISES IMPLEMENTATION

Next to the interpretation of an impact to the business in the case of cloud computing the effects of an on premises implementation are also plotted per Zachman cell in the table below.

	What	How	Where	Who	When	Why
Contextual		4				
Conceptual	4	3,5	4	4		
Logical	3	3	3	3		1
Physical	3	3	3	2	1	1

Table 29 interpretation of a on premises implementation

Compared to a cloud implementation, an on premises implementation, interpretation of impact to the business is rated lower, which means it had a negative impact to the business. Mainly in the physical layer the scores are neutral (3,0) or negative (2,0 and 2 times 1,0).

7.3 CONTEXTUAL

In the figure below shows the expectation of the impact of cloud computing for the contextual layer on the enterprise architecture is shown together with the measured values from cloud and on premises implementations. In the contextual layer the business strategy is described.

	What	How	Where	Who	When	Why
expectation	0	0	3	0	0	0
cloud	0	0	3,5	0	0	0
on premises	0	1	0	0	0	0

Table 30 expectations versus results in the contextual layer

Based on these scores we can conclude that the expectation that cloud computing has impact in the "***where***" cell of the contextual layer is confirmed.

This "***where***" cell is normally filled with the business locations, in the explanation which was asked during the interviews respondent #9 responded that the process is now also active in foreign offices. The impact had a positive interpretation to the business, they gave a 5 score to the interpretation of the impact which means it has a big positive interpretation to the business.

The "1" score for on premises in the "***how***" cell can be explained due the fact that the new implemented system was merged with a process optimization with was forced by a national standard. Respondent #4 responded with "due to the new standardized way of work we need more central alignment and we could not chose or way of work". When we look closer at the interpretation of impact, we see that the interpretation to the business was rated with a 4 which is positive interpretation to the business.

	What	How	Where	Who	When	Why
cloud			5			
on premises		4				

Table 31 Interpretation of the impact

7.4 CONCEPTUAL

The conceptual layer is also called owner layer, this layer provides more information on the operation of the strategy set in the contextual layer. Same as done for the contextual layer the score from the expectation, cloud and on premises implementation are displayed in the table below.

	What	How	Where	Who	When	Why
expection	0	3	5	0	0	0
cloud	1,7	3	2	4	0	2
on premises	1	2	1	2	0	0

Table 32 expectations versus results in the conceptual layer

In the scores two cells show remarking values, the "***who***" cell was impacted especially in the case of a cloud implementation. And the score of the "***where***" cell was lower than expected.

The reason why the "***who***" cell was impacted, is that organizations feel that they "change from a producing role to a director role" as stated from respondent #8 and #9.When looked closer at this statement and why is was stated it could be the effect of an new process implementation rather than the implementation of cloud computing.

The reason why the "***where***" cell impacted lower as expected is a unknown, especially since the score for this cell was higher in the layer above this layer (contextual). When the explanations are looked into respondent #1 stated the working from home is a possibility but rated the cell with a low score which lowered the average score for the cell.

For this layer the interpretations of the impacted cells are plotted into the table below

	What	How	Where	Who	When	Why
cloud	4	4,3	5	4		5
on premises	4	3,5	4	4		

Table 33 Interpretation of the impact

As seen the "***who***" cell was impacted which was not expected, the interpretation of this impact however was very positive to the business. The can be traced back to the new role respondent #8 and #9 stated (more director role instead of producing role).

7.5 LOGICAL

In the logical layer are further refined with the design elements and data flows. This refinement is needed for the eventual realization to achieve.

	What	How	Where	Who	When	Why
expectation	3	3	5	0	5	3
cloud	2,2	3,5	2,4	2,7	1,7	2,8
on premises	5	0,5	0,5	0,5	0,5	4

Table 34 expectations versus results in the logical layer

The cells that surprise are the "***where***" cell which is lower than expected and the "***what***" cell which is extremely high with a on premises implementation.

When the statements of the respondents are investigated in more detail a reason for this low impact in the "***where***" cell, can be found in the positive reactions on the outplacement of the service infrastructure. Respondent #3 stated that "all systems are gone, so no worries".

The "***what***" cell is rated with a 5, which means the logical data model is completely different than expected. This is a rather strange score for a on premises implementation, but can be explained due the fact that the implemented solution was a standardized solution which used a complex data model according to respondent #5.

	What	How	Where	Who	When	Why
cloud	3,7	3,3	4,3	2,7	2,5	3,3
on premises	3	3	3	3		1

Table 35 Interpretation of the impact

When the interpretations of the impact are plotted we can see the scores are getting more into the negative side of the rating scale. This means the positive interpretations mainly are seen in the higher layers of the Zachman framework. Based on the responses from the respondents the conclusion can be made that is due to a mismatch from client expectation and service offering. Besides this negative trend the "***where***" cell still is rated very positively since the service infrastructure is not at the client side and responsibility. Also a low score on the "***why***" cell is in line with the high impact this cell has, this can be traced back to impossibilities in realizing business rules within the service respondent #5 "limited adjustment possibilities"

7.6 PHYSICAL

The physical layer, called builders layer also contains information on how the system should look like and what requirements it must meet. But it has a more technological solution goal then the logical layer.

	What	How	Where	Who	When	Why
expectation	5	3	5	3	5	3
cloud	2,7	2,7	4,3	2,5	1,5	4
on premises	1	1	2	1	1	2

Table 36 expectations versus results in the physical layer

In the table above the on premises scores are again lower than the cloud scores. Within the score the "***why***" cell for cloud computing is higher than expected and the "***what***" and "***when***" scores are rated lower than expected.

The high score in the "***why***" cell for cloud implementations can be traced back to respondent #7 who rated the cell with a big impact, but also as a positive impact (as can be seen in the table below). The "***what***" and "***when***" cells for cloud implementations are rated lower because it matched the exact expectation (respondent #7).

When looked at the interpretations of the impact the who cell for cloud and the "***when***" and "***why***" cells for on premises implementations shows low scores on the other hand the "***why***" cell for cloud computing shows a high score.

	What	How	Where	Who	When	Why
cloud	4	3,5	3	1	3	5
on premises	3	3	3	2	1	1

Table 37 Interpretation of the impact

The "***when***" and "***why***" cells in the on premises implementation can be traced back to respondent #6 who stated that "our expectations where based on wrong principles which were implemented into the system". This shows that the principles of a system must be good right from the start. The "***why***" cell for cloud implementations was rated with a 5 score based on the more flexible solution that was offered. This is a contrasting score between cloud and on premises implementations, that show that cloud computing provided a better solution for the business.

7.7 PROJECT SUCCESS

As mentioned in the research structure (paragraph 1.4) project success is measure with the EFQM model. Below are the different aspects of the model. Per aspect a score from 1 to 5 was given for the cloud implementation.

	Cloud	On premises
Time	4,2	2,5
Cost	4,3	1
Quality	4,3	3,5
Scope	4,6	4
Customer	4,4	4
Project members	4,3	3
Users	4,8	3,5
Partners	3,5	4
Stakeholders	4	
Total	4,2	3,2

Table 38 Project success results

Legenda
Positive effect
Neutral
Negative effect
No effect

Table 39 legenda for Table 38

Overall we can conclude that the scores for a cloud implementation are higher with a score of 4,2 than with a on premises implementation which has a score of 3,2. This means that a cloud implementation is rated better by the different stakeholders, this supports the stated hypothesis (see Table 11 Hypothesis 2

).

The "***partners***" score however is rated less by stakeholders from a cloud implementation , this can be the result of standardized and difficult interfaces that cloud providers offer which has to be used by the partners. Besides the difficult interface to contact with these cloud providers goes through a formal channel like e-mail which can result in a trial and error implementation of the interfaces.

The "**time**" aspect of cloud computing wins with a big difference, this can be found back in the interviews, where the extremely fast implementation time is mentioned as a big advantage. In the interviews the following statements can be traced back to implementation time: Respondent #7 "*good conversion and everything went very fast*" and respondent #2 "*the implementation went too fast our organization wasn't able to cope with the speed of change*"

Next to the fast implementation the "**cost**" aspect also shows a big difference in scores. This shows that cloud computing promise of pay per use results into a price advantage for the users.

Besides the “***price***“, “***time***“ and “***quality***“ is also a important aspect in projects, on as scale of 0 to 5 cloud implementations scores a 0.8 higher than the traditional implementation. This can be explained by the fact that cloud systems are used by many organizations so it is tested profound in practice next to the normal system tests.

The other facts are the satisfaction of the different stakeholders of the project, besides the mentioned partner stakeholder the different stakeholders rate cloud implementations higher then on premises implementations. Especially the users of the system rate it with 1.3 point higher, this can be explained due to the clear view there is what a product offers.

7.8 CONCLUSION

As explained in the paragraphs before cloud computing has mainly impact on the where row and on the other rows starting from the logical layer down to the physical layer in the Zachman framework.

The table below shows again the scores from 1 to 5 where cloud computing was impacted, where a 5 shown there is a big impact and a 0 means no impact.

	What	How	Where	Who	When	Why
Contextual	0	0	3,5	0	0	0
Conceptual	1,7	3	2	4	0	2
Logical	2,2	3,5	2,4	2,7	1,7	2,8
Physical	2,7	2,7	4,3	2,5	1,5	4

Table 40 impact of cloud computing on the Zachman framework

This impact of the where cell is higher but also rated more positively which means that the impact was good for the business, it revealed new possibilities for the business such as new working locations. This is clearly visible in the high scores in the where row where a 5 is a positive interpretation and a 0 a negative interpretation.

	What	How	Where	Who	When	Why
Contextual			5			
Conceptual	4	4,3	5	4		5
Logical	3,7	3,3	4,3	2,7	2,5	3,3
Physical	4	3,5	3	1	3	5

Table 41 interpretation of the impact of cloud computing

Next to the positive interpretations of the business the project success with cloud computing implementation is also higher rated the on premises implementation. With these scores there is visible that cloud computing is getting a higher score on most aspects of project success. Only on the partner aspect of cloud computing there was a lower score.

	Cloud	On premises
Time	4,2	2,5
Cost	4,3	1
Quality	4,3	3,5
Scope	4,6	4
Customer	4,4	4
Project members	4,3	3
Users	4,8	3,5
Partners	3,5	4
Stakeholders	4	
Total	4,2	3,2

Table 42 project success score of cloud computing versus a on premises

8 CONCLUSIONS

Within this thesis the impact of cloud computing is examined with the use of the Zachman framework. In this thesis we see impact as a change in the expected state of an implementation. The effects where disposed to the impact of organizations which did not use cloud computing. When impact was detected the value to the business was measured in term of positive or negative interpretation to the business. Next to the impact on enterprise architecture the project success was measured for both implementation types.

At the start of this thesis 2 hypotheses were posited based on these hypotheses, the research was structured. In the following paragraphs these hypotheses are being answered.

8.1 HYPOTHESIS 1: EFFECT OF CLOUD COMPUTING TO ENTERPRISE ARCHITECTURE

The first hypothesis was based on the thought that cloud computing does not change the way a company works but only facilitates the realization of the chosen strategy. Therefore the impact of cloud computing was expected in the realization layers of enterprise architecture.

Cloud computing impacts the operational layers in a enterprise architecture framework

Table 43 Hypotheses 1

This hypotheses was detailed in more depth with the use of the Zachman framework for enterprise architecture. The Zachman framework was chosen because it was the basis for many modern frameworks. Within the Zachman framework the following impacts where expected (green is no impact, and orange is complete impact).

	What	How	Where	Who	When	Why
Contextual						
Conceptual						
Logical						
Physical						
As Built						
Functioning						

Table 44 Expected impact of cloud computing on the zachman framwork

In the validation phase of this research the impacts where validated within 2 organizations which implemented a cloud solution for their core admission process, in order to dispose effects that are not accountable to cloud computing an organization who implemented a on premises solution for the same process was also investigated.

Based on the interviews the following impact was found in the case of cloud computing (0 is no impact and 5 is complete impact)

	What	How	Where	Who	When	Why
Contextual	0	0	3,5	0	0	0
Conceptual	1,7	3	2	4	0	2
Logical	2,2	3,5	2,4	2,7	1,7	2,8
Physical	2,7	2,7	4,3	2,5	1,5	4

Table 45 impact of cloud computing on the Zachman framework

Based on these values we can conclude that cloud computing has mainly impact in the operational layers, starting at the logical level. Since a impact do not give the value of this change to the business the interpretation of the impact was also investigated this resulted in the following scores (where 5 is positive an 0 negative) .

	What	How	Where	Who	When	Why
Contextual			5			
Conceptual	4	4,3	5	4		5
Logical	3,7	3,3	4,3	2,7	2,5	3,3
Physical	4	3,5	3	1	3	5

Table 46 Interpretation of the impact on the Zachman framework

Based on these values we can conclude that the impact of cloud computing to cells in the Zachman framework is there, but the interpretations of these impacts are positive to the business.

As mentioned in the architecture maturity model of Ross, J., Weill, P., & Robertson, D. (2006) one of the advantages should be the standardize infrastructure this is in line with cloud computing since an normal internet connection is enough to access the application. Another advantage is the number of platforms are reduced, since cloud computing has hidden the platform for the users this advantage is also realized. This means cloud computing gives the organizations some of the advantages of the 2nd level of the architecture maturity model, the complete check upon which level the organizations are after in cloud implementation where not placed within this theses.

8.2 HYPOTHESIS 2: THE EFFECT OF CLOUD COMPUTING ON PROJECT SUCCESS

Next to the impact of cloud computing to enterprise architecture, how cloud computing effects the project success was investigated. The implementation is said to be one of the big advantages of cloud computing. This hypotheses validates that promise.

Cloud computing results in a greater project success

Table 47 Hypotheses 2

To validate if this hypotheses is true the different aspects of project success according to the EFQM framework where used to compare project success result between on premises implementations and cloud implementation. The EFQM framework was chosen because it combine many other project success methods into one framework.

	Cloud	Onpremises
Time	4,2	2,5
Cost	4,3	1
Quality	4,3	3,5
Scope	4,6	4
Customer	4,4	4
Project members	4,3	3
Users	4,8	3,5
Partners	3,5	4
Stakeholders	4	
Total	4,2	3,2

Table 48 project success score of cloud computing versus a on premises

The biggest difference in scores is seen on the cost aspect cloud computing was rated a 4.3 where on premises got a 1 rating. Only the partner aspect was rated lower in the case of cloud computing, this can be explained by the formal relations between the user and provider. In general one can say that cloud computing has a better score on project success aspects which means cloud computing has a higher project success in.

8.3 CONCLUSION

Based on the outcomes of the hypotheses the conclusion can be made that cloud computing has impact on the implementation details of a strategy, but this impacts brings a positive interpretation to the business. Next to the positive effects the implementation of a cloud solution has a better result in terms of project success which means the project and solution fit better to the organization and users.

9 FUTURE RESEARCH

9.1 A BROADER RESEARCH

With the used questionnaire a broader context can be investigated, this thesis focused on a higher education organization to find impacts. The found effects in other sectors can be different due to for example less or more process standardization in those sectors.

9.2 MORE QUANTITATIVE DATA ON PROJECT SUCCESS

This research used a relatively small group within a specific context (admission in higher education) to obtain data, with a larger group with a wider variation in context the results could give a more generic result which can be used for more global statement on the effects of cloud computing to enterprise architecture and projects success.

9.3 LINK BETWEEN PROJECT SUCCESS AND ENTERPRISE ARCHITECTURE

Based on this thesis we found the impact of cloud computing on enterprise architecture and that cloud computing gives a higher project success. In future research the relation between project success and enterprise architecture can be investigated. With these results one can say what changes in enterprise architecture can mean for project success. However we expect that enterprise architecture is not the only factor which contributes to project success, (Westerveld, 2003) suggests that the project organization influences the project success also.

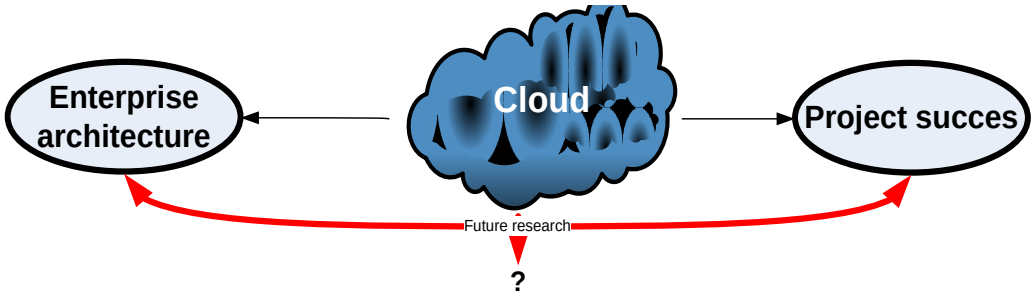

Figure 14 future research topics

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11 ADDENDUM

11.1 QUESTIONAIR BASED ON ZACHMAN FRAMEWORK

Based on the Zachman a questionnaire was developed, with this questionnaire each Zachman cell and every EFQM aspect was taken into account in the data gathering process. The selected respondents from the different organizations where asked how cloud computing impacted the situation from as-is to to-be. To determine the impact they were asked to use the situation before the implementation as the expected situation. With this context we can see the difference between the as-is and to-be situation in the case of cloud computing without having the expectations of the respondents for cloud computing influencing the scores.

#	Layer	row	situation	Director	Manager	Functional IT staff	Technical IT staf	Maintenance Staff	users	question
1	contextual	What	Impact	x						Zijn de dingen die voor uw bedrijf/afdeling van belang zijn hetzelfde gebleven als voorzien?
2	contextual	What	Effect of Impact	x						Ervaart u de verandering positief of negatief?
3	contextual	What	Reason deviation	x						Waarom bent u afgeweken?
4	contextual	How	Impact	x						Zijn de bedrijfsfuncties die u voorzag gerealiseerd zoals voorzien?
5	contextual	How	Effect of Impact	x						Ervaart u de verandering positief of negatief?
6	contextual	How	Reason deviation	x						Waarom bent u afgeweken?
7	contextual	Where	Impact	x						Zijn de locaties waarop u uw functies wilde realiseren het zelfde gebleven als voorzien?
8	contextual	Where	Effect of Impact	x						Ervaart u de verandering positief of negatief?
9	contextual	Where	Reason deviation	x						Waarom bent u afgeweken?
10	contextual	Who	Impact	x						Zijn de betrokken rollen het zelfde gebleven als voorzien?
11	contextual	Who	Effect of Impact	x						Ervaart u de verandering positief of negatief?
12	contextual	Who	Reason deviation	x						Waarom bent u afgeweken?
13	contextual	When	Effect of Impact	x						Ervaart u de verandering positief of negatief?
14	contextual	When	Impact	x						Zijn de gebeurtenissen voor uw organisatie hetzelfde gebleven als voorzien?
15	contextual	When	Reason deviation	x						Waarom bent u afgeweken?
16	contextual	Why	Effect of Impact	x						Ervaart u de verandering positief of negatief?
17	context	Why	Impact	x						Is uw strategie hetzelfde gebleven als voorzien?

	ual									
18	context ual	Why	Reason deviation	x						Waarom bent u afgeweken?
19	concept ual	What	Impact	x	x					Is de bedrijfsdata die u onderkende hetzelfde gebleven?
20	concept ual	What	Effect of Impact	x	x					Ervaart u de verandering positief of negatief?
21	concept ual	What	Reason deviation	x	x					Waarom bent u afgeweken?
22	concept ual	How	Impact	x	x					Zijn de door u voorziene bedrijfsprocessen het zelfde gebleven?
23	concept ual	How	Effect of Impact	x	x					Ervaart u de verandering positief of negatief?
24	concept ual	How	Reason deviation	x	x					Waarom bent u afgeweken?
25	concept ual	Where	Impact	x	x					Zijn de door u voorziene locaties waarop de processen uitgevoerd worden het zelfde als voorzien?
26	concept ual	Where	Effect of Impact	x	x					Ervaart u de verandering positief of negatief?
27	concept ual	Where	Reason deviation	x	x					Waarom bent u afgeweken?
28	concept ual	Who	Impact	x	x					Zijn de rollen en verantwoordelijkheden u in uw processen hetzelfde als voorzien?
29	concept ual	Who	Effect of Impact	x	x					Ervaart u de verandering positief of negatief?
30	concept ual	Who	Reason deviation	x	x					Waarom bent u afgeweken?
31	concept ual	When	Effect of Impact	x	x					Ervaart u de verandering positief of negatief?
32	concept ual	When	Impact	x	x					Zijn de gebeurtenissen die worden ondersteund u in uw processen hetzelfde als voorzien?
33	concept ual	When	Reason deviation	x	x					Waarom bent u afgeweken?
34	concept ual	Why	Effect of Impact	x	x					Ervaart u de verandering positief of negatief?
35	concept ual	Why	Impact	x	x					Zijn uw bedrijfsdoelstellingen gelijk gebleven aan uw verwachtingen?
36	concept ual	Why	Reason deviation	x	x					Waarom bent u afgeweken?
37	logical	What	Impact		x	x				Is het logisch datamodel gelijk gebleven aan dat wat u had voorzien?
38	logical	What	Effect of Impact		x	x				Ervaart u de verandering positief of negatief?

39	logical	What	Reason deviation	x	x				Waarom bent u afgeweken?
40	logical	How	Impact	x	x				Zijn de ondersteunende systemen gelijk gebleven zoals voorzien
41	logical	How	Effect of Impact	x	x				Ervaart u de verandering positief of negatief?
42	logical	How	Reason deviation	x	x				Waarom bent u afgeweken?
43	logical	Where	Impact	x	x				Is het fysieke systeem landschap gelijk gebleven aan uw verwachtingen?
44	logical	Where	Effect of Impact	x	x				Ervaart u de verandering positief of negatief?
45	logical	Where	Reason deviation	x	x				Waarom bent u afgeweken?
46	logical	Who	Impact	x	x				Zijn de rollen en rechten binnen de functionaliteit gelijk gebelevn aan uw verwachtingen
47	logical	Who	Effect of Impact	x	x				Ervaart u de verandering positief of negatief?
48	logical	Who	Reason deviation	x	x				Waarom bent u afgeweken?
49	logical	When	Effect of Impact	x	x				Ervaart u de verandering positief of negatief?
50	logical	When	Impact	x	x				Zijn de ondersteunde gebeurtenissen en reacties gelijk aan uw verwachtingen?
51	logical	When	Reason deviation	x	x				Waarom bent u afgeweken?
52	logical	Why	Effect of Impact	x	x				Ervaart u de verandering positief of negatief?
53	logical	Why	Impact	x	x				Zijn de functie regels gelijk aan uw verwachtingen?
54	logical	Why	Reason deviation	x	x				Waarom bent u afgeweken?
55	physical	What	Impact		x	x			Is het fysieke datamodel gelijk gebleven aan uw verwachtingen
56	physical	What	Effect of Impact		x	x			Ervaart u de verandering positief of negatief?
57	physical	What	Reason deviation		x	x			Waarom bent u afgeweken?
58	physical	How	Impact		x	x			Zijn de processen in uw applicatie gerealiseerd zoals u had verwacht?
59	physical	How	Effect of Impact		x	x			Ervaart u de verandering positief of negatief?
60	physical	How	Reason deviation		x	x			Waarom bent u afgeweken?
61	physical	Where	Impact		x	x			Is de benodigde infrastructuur gelijk gebleven aan uw verwachtingen
62	physical	Where	Effect of Impact		x	x			Ervaart u de verandering positief of negatief?
63	physical	Where	Reason deviation		x	x			Waarom bent u afgeweken?
64	physical	Who	Impact		x	x			zijn d emogelijkheden voor het inregelen van autorisaties zo als u verwachte?

65	physical	Who	Effect of Impact			x	x			Ervaart u de verandering positief of negatief?
66	physical	Who	Reason deviation			x	x			Waarom bent u afgeweken?
67	physical	When	Effect of Impact			x	x			Ervaart u de verandering positief of negatief?
68	physical	When	Impact			x	x			Zijn de systeem gebeurtenissen gerealiseerd zoals voorzien?
69	physical	When	Reason deviation			x	x			Waarom bent u afgeweken?
70	physical	Why	Effect of Impact			x	x			Ervaart u de verandering positief of negatief?
71	physical	Why	Impact			x	x			Zijn de fysieke applicatie regels zoals u had verwacht/benodigd had?
72	physical	Why	Reason deviation			x	x			Waarom bent u afgeweken?
109	EFQM	Time	Impact	x	x					Hoe beoordeeld u de realisatie/implementatie tijd van het project?
110	EFQM	Cost	Impact	x	x					Hoe beoordeeld u de realisatie/implementatie kosten van het project
111	EFQM	Cost	Impact	x	x					Hoe beoordeeld u de realisatie/implementatie baten van het project
112	EFQM	Quality	Impact	x	x	x	x	x		Hoe beoordeeld u de kwaliteit van het project?
113	EFQM	Quality	Impact	x	x	x	x	x		Waarop baseert u dit?
114	EFQM	Scope	Impact	x	x	x	x			Heeft het project de gewenste doelen (scope) bereikt?
115	EFQM	Customer	Impact	x	x					Hoe waardeert u het project?
116	EFQM	Project members	Impact	x	x	x	x			Hoe waarderen de project medewerkers het project?
117	EFQM	Users	Impact	x	x				x	Hoe waarderen de gebruikers het project?
118	EFQM	Partners	Impact	x	x					Hoe waarderen de contract partners het project?
119	EFQM	Stakeholders	Impact	x	x					Hoe waarderen de project andere stakeholders het project?
120	Etc	Security	Impact	x	x	x				Aan welke beveiligingseisen voldoet u
121	Etc	Security	Impact	x	x			x	x	hebben zich beveiligings incidenten voorgedaan?
122	Etc	Support	Impact	x	x			x		Hoe is deze ondersteuning gerealiseerd?
123	Etc	Preformance	Impact	x	x	x	x	x	x	Welke preformance (snelheid, beschikbaarheid, aanpasbaarheid) is gerealiseerd?

Table 49 developed questionnaire

11.2 ANSWERS

question	1	2	3	7	8	9	4	5	6
1	0					0	0		
2									
3							introductie studielink		
4	0					0	1		
5							4		
6							centrale afstemming tussen gebruikers		
7	2					5	0		
8						5	-		
9						Ook gebruik op locaties buitenland is mogelijk			
10	0					0	0		
11									
12									
13									
14	0					0	0		
15							vanwege systeem, die kon niet alles aan		

16									
17	0					0	0		
18							systeem vereist een andere houding tov student		
19	3				0	2	0	2	
20	4							4	
21	Om te voldoen aan landelijke standaard					meer mail contact dus meer opslag		studielink	
22	5				2	2	2	2	
23	4				5	4	3	4	
24	Door aan te sluiten op landelijke systemen is een nieuwe werkwijze afgedwongen				meer regie rol	Van productie naar regie rol	aansluiting op landelijk systeem	studielink aansluiting	
25	0				1	5	0	2	
26	-				5	5		4	
27	nog niet, maar voorziet thuiswerken				thuis, andere vestiging	Ook vestigingen buitenland gebruiken functie		thuiswerken	
28	4				4	4	4	0	
29	3				5	4	4		
30	van een productie naar regie rol				meer duidelijkheid door systeem	regie rol geworden	meer proces gericht ipv taakgericht		
31	-								
32	0				0	0	0	0	

33	-								
34	-				5				
35	0				4		0	0	
36	-				efficienter, andere benadering naar student				
37	4	0	0	4	3			5	
38	1		-	5	5			3	
39	iets complexer geworden vanwege genericiteit		-	makkelijker geworden	eenvoudiger			lastiger op bepaalde punten, door meerdere klanten	
40	3	4	2	5				0	1
41	4	0	4	5					3
42	minder ondersteuning van eigen scripts	minder mogelijkheden tot eigen scripts/bijbouw	extra koppelingen benodigd	meer mogelijkheden voor integratie					
43	0	1	2	5	4			0	1
44	-	3	4	5	5				3
45	-	verbindingen traag of brak	geen last meer van fysieke server	alle systemen zijn weg, dus geen zorgen van	server staat ergens anders				
46	5	3		0	2			0	1
47	1	2			5				3
48	minder mogelijkheden dan gewenst	beperkte mogelijkheden tot afschermen velden			meer mogelijkheden tot inzage andere systemen				

49	2	3							
50	4	1		0				0	1
51	systeem is nog ontwikkeling								3
52	2	2		4	5			1	
53	4	1		2	4			5	3
54	nee, voldoen aan gezamenlijke standaard	minder eigen regels mogelijk		wat meer inregel mogelijkheden dan verwacht	meer mogelijkheden			beperkte inregel mogelijkheden	
55		3		4					1
56		3		5					3
57		is complexer geworden door leverancier		eenvoudiger geworden					
58		4	4	0					1
59		5	2						3
60		door aansluiting op standaard	Beheer processen zijn niet helder						
61		3	5	5					2
62		3							3
63		Snellere internet lijn							
64		5		0					1
65		1							2
66		kan zelf niet ingeregeld worden maar via service desk							
67		3							1
6		3		0					1

8									
69		beperktere vrijheden							onze uitgangs-punten waren onjuist maar wel geïmplemen-teerd
70				5					1
71		3		5					2
72		3		meer business rule instelbaar					onze uitgangs-punten waren onjuist maar wel geïmplemen-teerd
109	5	1		5	5	5	2	3	
110	5			5		3	1		
111	3	3		5	5	4	3	4	
112	4	3		5		5	4	3	
113	korte lijnen, snelle reacties	Moeizaam begin, gedwongen snelle invoer		goede conversie alles ging erg snel	snel, geen fouten,	snel was een must	te snel geimplementeerd, de organisatie was nog niet zo ver, maar wel goede support en proactief	veel ging goed, echter gingen er dingen mis waar men later achterkwam	
114	3		5	5	5	5	3	5	
115	5	3	4	5		5	4	4	
1		3		5		5	3		

116									
117			4	5	5	5	3	4	
118			4		3		4		
119			4		4	4			
120			beveiligde lijn, username pass	zie sla	zie SLA, versturen inlog gegevens via verschillende kanalen	zie SLA	SL eisen	token	
121	nee	nee	nee	nee	nee	nee	nee	nee	
122			prachmatisch, gericht op incidenten	FB intern en gebruikers groepen met leverancier	FB intern en korte lijnen met leverancier foxbugs om bugs / changes te melden	Functioneel beheer intern en een gebruikersgroep voor nieuwe wensen	korte lijnen		
123	snelheid:ok, beschikbaarheid ok, aanpasbaarheid snel maar ongestructureerd	snelheid: variabel, beschikbaarheid: matig door inet, aanpasbaarheid, snel maar leidt tot irritatie vanwege adhoc oplevering		snelheid: goed, beschikbaarheid: goed, aanpasbaar-heid: goed	snelheid goed, beschikbaarheid: prima: aanpasbaarheid ok	snelheid goed, beschikbaarheid goed, aanpasbaarheid goed	snelheid: langzaam, beschikbaarheid: beperkt problemen, aanpasbaarheid, beperkte vanwege andere klanten	snelheid. Langzamer, beschikbaarheid: minder, aanpas, sneller	
			bedrijf heeft geen strategie omtrend cloud						
			onduidelijke risico's						
			geen architectuur visie voor onderwijs						
			implementatie partner moet strakker helpen sturen in interne						

			beheer processen						

Table 50 answers of the respondents

11.3 ARTICLE BPM MAGAZINE

The following article was published in the internal BPM magazine for September 2010 of Capgemini Netherlands, therefore the article is in Dutch.

11.3.1 BPM APP STORE

Stel je voor een iphone zonder apps, dat zou de iphone een stuk minder waardevol maken. Dit zelfde concept zou doorgetrokken kunnen worden naar de business proces wereld, wat heb je aan een goede business proces engine zonder aan te kunnen haken op standaard services. Wanneer er voor een business proces engine een soort app store zou zijn komt het alom bekende lego blokjes concept weer een stuk dichterbij. De gebruiker kan te pas en te onpas een nieuwe functie toevoegen aan het proces. Zeker wanneer deze concepten beschikbaar gesteld worden in de cloud biedt dit ongekende mogelijkheden.

11.3.1.1 CLOUD COMPUTING

Om een helder beeld over cloud computing te krijgen staat hier onder de definitie, die het NIST (National Institute of Standards and Technology) heeft samengesteld

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models(NIST, 2009)

Zoals in de definitie gemeld zijn er 3 lagen van cloud computing:

- SaaS: waarbij software wordt aangeboden
- PaaS: waarbij een platform met ontwikkel tools wordt aangeboden
- IaaS: waar computer en opslag capaciteit wordt aangeboden

Maar de verschillende lagen hebben allen wel de kenmerken van: gedeelde resources welke schaalbaar zijn en bereikbaar via een netwerk. Cloud services worden weer in 4 verschillende modellen beschikbaar gesteld:

- Public: de service is via het publieke internet te bereiken
- Private: de service is enkel via het eigen bedrijfsnetwerk te bereiken
- Community: de services worden gedeeld tussen enkele organisaties (b.v. een shared service center)
- Hybrid: een combinatie van bovenstaande componenten

11.3.1.2 CLOUD SERVICES EN BUSINESS PROCESSEN

Nu is er al veel geschreven over hoe SOA business proces management niet alleen vereenvoudigd maar ook nodig heeft (Weske, 2007). Cloud computing voegt hier nog een extra dimensie aan toe, omdat het ook weer verder voortbouwt op SOA. De services zitten nu niet meer binnen de organisatie, maar worden vanuit een cloud gebruikt en gedeeld met meerdere afnemers. Zo wordt het voor organisaties eenvoudiger en goedkoper om services te gebruiken, aangezien ze niet speciaal voor de organisatie ontwikkeld zijn en beheerd hoeven te worden.

11.3.1.3 CORDYS PROCESS FACTORY (CPF)

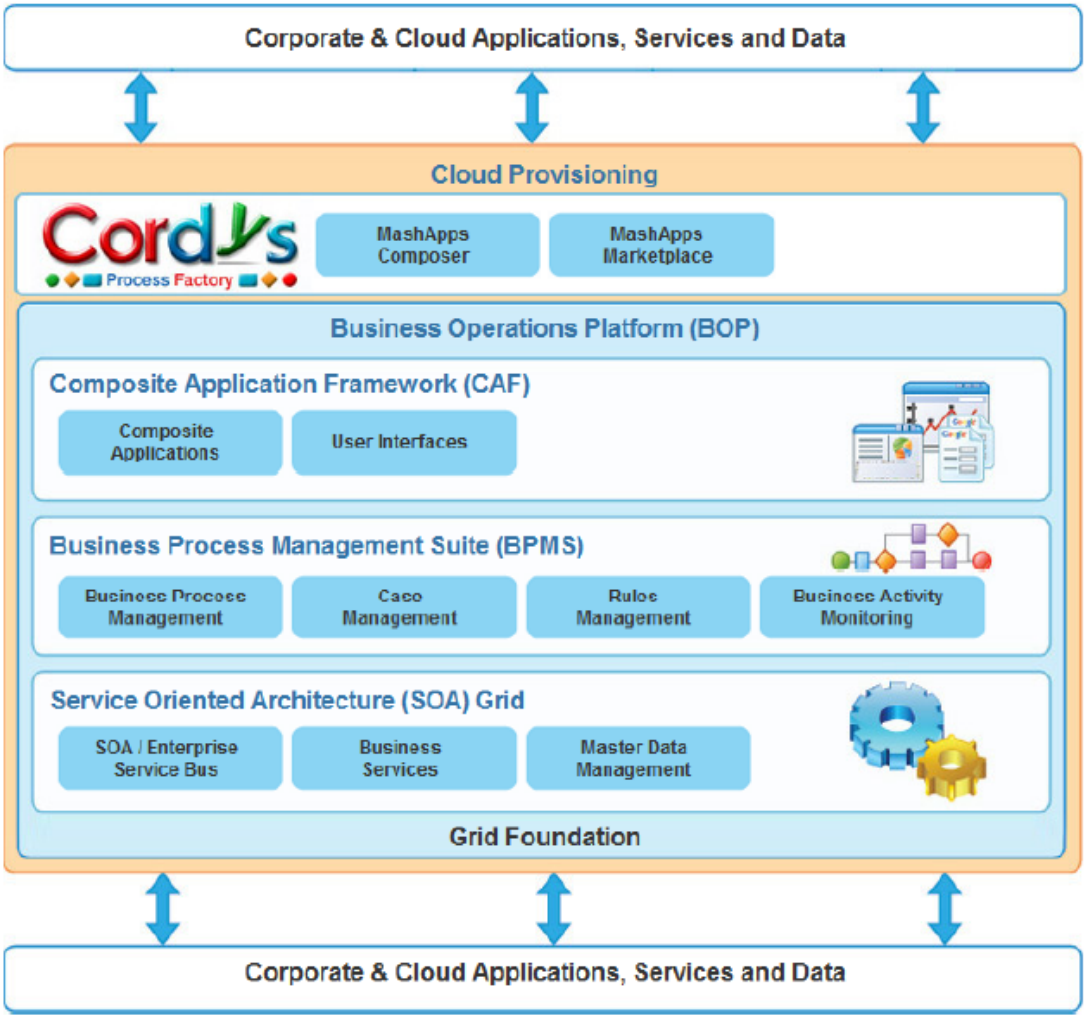
Om op deze ontwikkelingen in te spelen heeft het Nederlandse bedrijf Cordys (www.cordys.com) een platform ontwikkeld waarmee zij de visie van cloud services in combinatie met een business proces management tool en een app store wil realiseren. Dit platform wordt Cordys Process Factory genoemd.

Volgens de marketing slogan staat het CPF voor:

“The Cordys Process Factory offers a solution to create new business processes and web-based, process-centric applications. Users of Cordys Process Factory can create customized mash-up applications or MashApps by combining standard business applications like Google Apps and commercially available services, with Web services from anywhere.

Cordys Process Factory is powered by Cordys and provides many of the Cordys Business Operations Platform capabilities in a SaaS model. The online modeling environment is built on top of the Cordys Business Operations Platform.

Cordys Process Factory also supports community building by offering a community Portal, where users can come together and share their MashApps and exchange ideas. Cordys Process Factory also provides an online marketplace for different categories of ready to use MashApps. Some of these MashApps are paid while some of them are free.”(Baan, 2010)



Figuur 1 Cordys platform Cordys (2010)

Het platform CPF is gesitueerd bovenop het Business Operations Platform (BOP) van Cordys. Dit is ook het platform dat gebruikt wordt als men van Cordys gebruik maakt buiten de Cloud. Het BOP-platform combineert een uitgebreide business proces management suite met een service bus welke kan praten met business services uit lecacy applicaties of uit gecombineerde data uit een gegevens magazijn. Tot nu toe weinig vernieuwends vele BPMS platformen bieden dit soort technologieën. Maar binnen CPF draait dit allemaal op servers in de Cloud waardoor de infrastructuur binnen de organisatie minder complex en redundant uitgevoerd hoeft te worden.

Daarnaast biedt Cordys het Composite Application Framework (CAF). Met CAF kan informatie uit verschillende bronnen, zoals legacy applicaties, business services en web content, gecombineerd worden weergeven in een portaal. Dit portaal wordt meegeleverd met BOP. Om het helemaal af te maken wordt er bovenop CAF ook een MashApps Composer aangeboden binnen CPF. Met deze MashApps Composer kunnen applicaties worden gebouwd. Deze applicaties draaien in de Cloud en maken gebruik van de onderliggende mogelijkheden van het platform.

Ook biedt Cordys daarnaast een app store waar gemaakte MashApps gedeeld kunnen worden met andere gebruikers. Uiteraard zit hier voor zowel Cordys als de maker van de MashApp een financieel model achter.

Het financieel model is vastgelegd binnen de laag Cloud Provisioning. Deze laag zorgt voor de administratie wie, wanneer, hoe vaak gebruik maakt van een MashApp. Zo wordt het mogelijk om het gebruik van de MashApp af te rekenen op basis van “pay per use”

11.3.1.4 UITDAGINGEN

Natuurlijk brengt dit uitdagingen met zich mee. Zo is er de eeuwige uitdaging op het gebied van gegevensdefinitie; Hoe zorg je er voor dat een klant in de ene service hetzelfde is gedefinieerd als in de andere.

Daarnaast is versionering ook een uitdaging. Cloud services worden continue verbeterd en aangepast. Voor een consumenten service als gmail zal dit niet tot grote problemen leiden, maar in complexe bedrijfssituaties kan dit voor onaangename verassingen zorgen. Om dit soort problemen te voorkomen zal backwards compatibiliteit een grote wens zijn van de afnemers. Alleen op die manier hoeven afnemers niet continu hun systeem aan wijzigende interfaces aan te passen.

Naast de technische beperkingen zijn er ook juridische beperkingen, organisaties (overheden) hebben vaak regelgeving over waar hun data mag staan. Zo is er sinds 1998 in de Europese Unie een Privacy richtlijn, die het exporteren van persoonsgegevens naar landen buiten de EU verbiedt tenzij het land in kwestie een minstens even strenge privacy wetgeving kent. Echter is het met cloud computing vaak onduidelijk waar gegevens staan, hoewel sommige aanbieders bezig zijn met oplossingen of al oplossingen hebben.

11.3.1.5 CONCLUSIE

Dit alles klinkt natuurlijk wel weer als het mooie “klik-en-klaar” verhaal, maar er is wel wat technische kennis benodigd. Zo moeten de verschillende MashApps wel met elkaar gaan “praten”. Hierbij komen weer webservices en data transformaties aan het licht en dan hebben we het nog niet eens over de business rules, die ingeregeld moeten worden. De marketing verhalen melden dat business users dit zelf zouden kunnen. Echter ben ik nog niet veel business users, die eenduidig een business rule in een applicatie kunnen beschrijven, tegen gekomen.

Ondanks deze beperkingen biedt Cordys een prachtig platform met veel toekomst. Zo zullen er vele MashApps ontwikkeld kunnen worden en mogelijk zelfs al wat standaard integratie koppelingen tussen enkele MashApps.

11.3.1.6 REFERENTIES

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11.4 ARTICLE: THE IMPACT OF CLOUD COMPUTING ON ENTERPRISE ARCHITECTURE

11.4.1 THE IMPACT OF CLOUD COMPUTING ON ENTERPRISE ARCHITECTURE

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Keywords: Cloud computing, enterprise architecture, Zachman

Abstract: This research investigates the impact of cloud computing on enterprise architecture, to position these effects the Zachman framework was used. First the effects where distilled from existing literature and later validated in real-life cases. The outcome is that cloud computing has impact on the implementation details of a strategy, but this impact bring a positive effect to the business.

11.4.1.1 INTRODUCTION

Currently, many companies are interested in using cloud computing capabilities, but they do not know where to expect effects when choosing for the cloud computing concept (Joint, 2009). When it is more clear for organizations what the effects are of cloud computing, and how these could be tackled, An

organization can make a more informed choice about using cloud computing for certain functionality. Within this research the effects are investigated based on current literature and presented with the use of the Zachman framework for enterprise architecture. The findings from the literature where validated in a real life cases where cloud computing was used to support a business function within the context of an admission process within higher education organizations.

11.4.1.2 CLOUD COMPUTING

There is much discussion in the industry about the exact definition of cloud computing. In this paper we adopt the definition of cloud computing which is proposed by the NIST.

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models.(NIST, 2009).

In the following paragraphs the different characteristics, service models and deployment models are described.

11.4.1.3 CHARACTERISTICS

As mentioned in the NIST definition cloud computing consists of five characteristics, these characteristics are pay per use, scalability, use of internet technology, self service, multitendancy.

- Pay per use – Cloud services are shared among different users therefore economies of scale can be applied. This results in an payment model which makes it possible for users to pay for the real use e.g. Based on CPU usage)(Armbrust, et al., 2009)
- Scalability – The usage of the cloud services can differ from time to time, to provide a stable availability it should be possible to scale up the resources so it is also available in peak times, and scale down in low usage time. This characteristic is realized through the use of virtualisation technology (Buyya, Yeo, Venugopal, Broberg, & Brandic, 2009)
- Use of internet technology - The services are offered to different platforms such as windows, apple, PDA and available from every location. To realize this a standardized internet protocol is used to offer the services, this doesn't demand special software for a service on the clients device. (Weiss, 2007)
- Self-service – computing services can be acquired and used at anytime without the need for human interaction with cloud service providers. Computing services include processing power, storage, virtual machines , user access (Sriram & Khajeh-Hosseini, 2010)
- Multitendancy – The realize a cost effective model in combination with the scalability characteristic a provider must provide its services to multiple customers (Motahari-Nezhad, Stephenson, & Singhal, 2009).

11.4.1.4 SERVICE MODELS

The chararistics of cloud computing are offered in different service models, these models deliver their services to different types of users. In the figure shown below the type of user per service model is shown. The service models are also called the cloud stack.

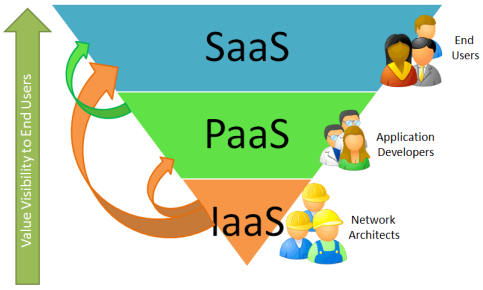

Figure 1 Cloud computing stack (Schuller, 2010)

SaaS

Software as a Service (SaaS): is cloud computing layer where users simply make use of a web-browser to access software that others have developed, maintain and offer as a service over the web. At the SaaS level, users do not have control or access to the underlying platform and infrastructure that is being used to host the software. Salesforce's Customer Relationship Management and Google Gmail are popular examples that use the SaaS model of cloud computing.(Armbrust, et al., 2009)

PaaS

Platform as a Service (PaaS): is the layer where applications are developed using a set of programming languages and tools that are supported and provided by the PaaS provider. PaaS provides developers with a high level of abstraction that allows them to focus on developing their applications. Developers can provide their customers with a custom developed application without the hassle of defining and maintaining the infrastructure. Just like the SaaS model, users do not have control or access to the underlying infrastructure being used to host their applications at the PaaS level. Google App Engine and Microsoft Azure are popular PaaS examples.(Boniface, et al., 2009)

IaaS

Infrastructure as a Service (IaaS): is the lowest layer where users use computing resources such as databases, CPU power, memory and storage from an IaaS provider and use the resources to deploy and run their applications. In contrast to the PaaS model, the IaaS model allows users to access the underlying infrastructure through the use of virtual machines which automatically can scale up and down. IaaS gives users more flexibility than PaaS as it allows the user to deploy any software stack on top of the operating system. However, flexibility comes with a cost and users are responsible for updating and patching the operating system at the IaaS level. Amazon Web Services' EC2 and S3 are popular IaaS examples.(Murphy, Abraham, Fenn, & Goasguen, 2009)

11.4.2 DEPLOYMENT MODELS

The different service models can be delivered to the users trough four different deployment models, based on type of use and security demands of a service it can be deployed locally in the public or a deployment model which can be positioned in between these models. Below are the different deployment models.

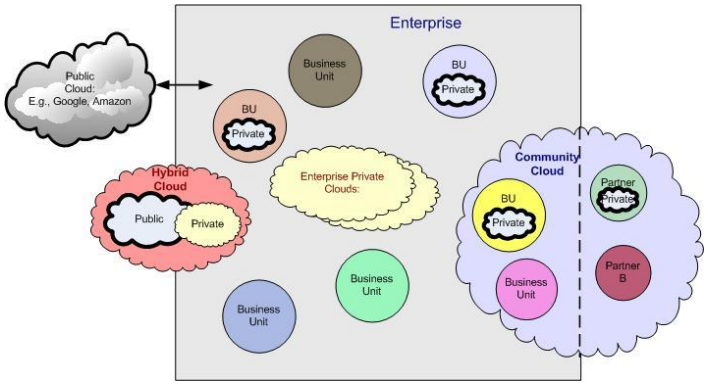

Figure 2: deployment models (Brown, 2009)

Public

Is a deployment strategy which uses the publicly available internet to deliver the services to the users. A great advantage of this deployment type is that the services is available for any internet connection, an down side however is the security. The cloud services like Gmail and Azure are services provided trough the public cloud.(Armbrust, et al., 2009)

Private

This deployment strategy can be compared with the traditional in-house hosting of a service, however it uses the technologies on which cloud computing is based such as virtualization to provide advantages to the organization.(Armbrust, et al., 2009)

Community

A community cloud is a bit like a private cloud however the cloud is share among a community of organizations. This is done to divide the costs and risks of running an own cloud. These cloud can be found in share service centers which service multiple organizations.(Buyya, et al., 2009)

Hybrid

A hybrid cloud is a cloud computing environment in which an organization provides and manages some resources in-house and has others provided externally. For example, an organization might use a public cloud service, such as Amazon's Elastic Compute Cloud (EC2) for general computing but store customer data within its own data centre. (Cole, 2009)

11.4.3 ENTEPRISE ARCHITECURE

Enterprises are getting more complex by the day, they have to deal with strong competition, much and complex legislation and fast changing whishes from customers. All these factors have their impact on the functioning of an enterprise. An organization has to get a balance between these factors. The discipline that creates the balance between all these factors is enterprise architecture. The formal definition of enterprise architecture according to IEEE is:

The Architecture (of a system) is the fundamental organization of that system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution.(IEEE, 2000)

Zachman

In eighties of the 21 century Johan Zachman was confrontated with these effects and decided to develop a framework which helps organizing and rationalizing the architecture of a enterprise. Zachman made an analogy with the construction of a building. With the construction of a building one needs an architect to develop an sketch of a building according to the wishes of a customer and to process goes further till the building is build and in use. In Zachman's framework a same analogy is used. The framework consists of 6 rows and 6 columns, the columns are about the questions on how, what where, who, when and why. On the crossing of a column with a row information is given on how the question for the column can be answered. Thus the intersection (cell) between why and contextual reasons why the organization wants, why does it stets himself the goal.

11.4.4 IMPACT OF CLOUD COMPUTING ON ZACHMAN CELLS

11.4.4.1 EFFECTS FROM LITERATURE

Based on the literature and from the view point of an existing organization the following cells of the Zachman framework are impacted.

	What	How	Where	Who	When	Why
Contextual						
Conceptual						
Logical						
Physical						
As Built						
Functioning						

Table 1 Effects of cloud computing positioned in the Zachman Framework

Legenda
No direct impact
Partly impacted
impacted

Contextual

In the contextual layer of Zachman the high level business context which depicts in gross terms the size, shape, partial relationships, and basic purpose of the final structure. In this layer not much effects are expected with the use of cloud computing, since the business is still doing the same thing as they did.(Broberg, Buyya, & Tari, 2009). The effect that is expected is that the internet technology offers possibilities to realize the work on other locations, this is shown in the where cell of the Zachman framework.

Conceptual

The conceptual layer is constituted with the designs of the business and show the business entities and processes and how they relate. This layer is not affected either, the high level business processes and entities stay the same.(Motahari-Nezhad, et al., 2009). Based on the found literature one can say that cloud computing does not influence the conceptual layer. This sounds logical since

the business goals are set in this layer, the only possible impact is in the how cell. This can happened due to complex organizational specific processes which need to be supported, but could not be realized with cloud services since these services must offer a standardized process which must fit in multiple organizations.

Logical

In the logical layer the first big impacted is expected, this is in line with the expected fulfillment of the cells. In this layer the service or application specific demands are distilled, since cloud computing offers a standardized solution we expect a mismatch between the business wish and the service possibilities. Due to the growing attention for Business process management and business rules management which make it possible to run processes or rules which are easily adjustable, because of these developments the how and why cells will be partly affected.

Physical

The physical layer consists of the technological aspects of the to realize solution. Cloud providers need to standardize their solutions to serve multiple customers, this means many whishes of customers could not be realized by the standardized solution. Things like processes, rules and roles use technologies which are at a mature stage (Rosca & Wild, 2002) which offer a way to easily logically change the aspects without changing the code. Due to this abstraction these cells are only partly affected.

11.4.4.2 EFFECTS IN PRACTICE

As expected cloud computing has mainly impact on the where row and on the other rows starting from the logical layer down to the physical layer in the Zachman framework.

The table below shows again the scores from 1 to 5 where cloud computing was impacted, where a 5 shown there is a big impact and a 0 means no impact.

	What	How	Where	Who	When	Why
Contextual	0	0	3,5	0	0	0
Conceptual	1,0	3	2	4	0	2
Logical	2,2	3,5	2,4	2,7	1,7	2,8
Physical	2,7	2,7	4,3	2,5	1,5	4

Table 2 impact of cloud computing on the Zachman framework

This impact of the where cell is higher but also rated more positively which means that the impact was good for the business, it revealed new possibilities for the business such as new working locations. This is clearly visible in the high scores in the where row where a 5 is a positive interpretation and a 0 a negative interpretation. Table below shows the interpretation of the impact of cloud computing.

	What	How	Where	Who	When	Why
Contextual			5			
Conceptual	4	4,3	5	4		5
Logical	3,7	3,3	4,3	2,7	2,5	3,3
Physical	4	3,5	3	1	3	5

Table 3 interpretation of the impact of cloud computing

11.4.5 CONCLUSIONS

Based on the outcomes of the validation we can conclude that the impact of cloud computing to cells in the Zachman framework is there as expected, and the interpretations of these impacts are positive to the business. In short this means that cloud computing had impact on the way an enterprise architecture is filled, but this impact is positive. The mean reason why cloud computing impacts the enterprise architecture is that cloud solutions offer a standardized solution which usually does not fit 100% the demand and/or expectation of the users.

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