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MASTER ICT IN BUSINESS

THESIS

ENTERPRISE DESIGN FOR A DIGITAL STUDY AND WORK ENVIRONMENT

CHANGES IN EDUCATIONAL LOGISTICS

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ABSTRACT

The digital work and study environment is subject to many changes due to rapid developments in IT, continuously evolving insights in didactic methods and constantly changing regulations, which give rise to many discussions within educational institutions. This thesis aims to provide a well-founded future-proof design for a digital work and study environment through research into the history of these environments and a close examination of the educational process set against the background of a case study of an existing setting within a medium sized institution for higher education.

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CONTENTS

1 INTRODUCTION

This thesis is the capstone of the ICT in Business program at Leiden University and contains the research study, which started in June 2012. The study focuses on the effect that emerging technologies and changing shareholder needs have on institutions of higher education with regards to the way digital study and work environments need to be designed and gives a summary of the theoretical backgrounds, findings and conclusions combined with a practical application in a case study.

1.1 BACKGROUND

A Digital Working and Study Environment (DSWE) represents the total of IT-services, which supports the activities of students, staff and guests of an institution of higher education and research (Technical Scientific Council, 2010). IT at institutions was initially used as an educational aid and not so much aimed at supporting the underlying business processes. Nowadays there is a growing conviction that focus on IT-services supporting educational processes leads to better performance and more satisfied stakeholders opposed to the use as an educational aid. Some arguments supporting this approach are:

- Integrated services result in time savings for students and staff which benefits education;
- It forces the institution to think about their supporting services thus standardizing (data) systems and enabling them for joint use;
- Creates the possibility for the support of differentiation of didactic models rather than a “one size fits all” policy.

Especially the argument for supporting a more process driven approach has become more and more current with Web 2.0 developments such as social media and online communities becoming more mature. Elaborating on this, some also argue that IT should be considered a part of the primary activities for an educational institution instead of a supporting one (van der Heiden, 2011).

1.2 PROBLEM STATEMENT

The digital playing field is changing for higher educational institutions as the use of social media takes flight in didactic applications and an increasing need to be connected to a wider variety of stakeholders develops. Although these developments are a good match with strategic values of educational institutions, they are also causing problems in the supporting business processes, which are supposed to be designed to aid the institutions in achieving their goals.

1.3 SOLUTION SUGGESTION

The objective of this study is to determine an enterprise design for educational institutions DSWE aimed at flexibility and connectivity with its stakeholders such as corporations, other educational institutions and governmental agencies, as well as students, staff and guests. HZ University of Applied Sciences (HZ hereafter) will function as a blueprint for this research in order to verify the findings.

1.4 RESEARCH OBJECTIVE

The initial research question, which is derived from the problem statement, is as follows:

How can emergent technologies and changing stakeholder needs, successfully be incorporated in higher education institutions?

Determine an enterprise design for educational institutions DSWE aimed at flexibility and connectivity for its stakeholders. HZ University of Applied Sciences will function as a blueprint for this research in order to verify the findings. The model aims to show the relationship between the IT- and business strategy and how this is supported and sustained by the Enterprise Architecture.

1.5 CASE STUDY

The case study aims to construct an enterprise design aimed at flexibility and connectivity for HZ, which will be conducted in cooperation with the Information provisioning and Automation services of HZ.

HZ is a medium sized university located in Zeeland in the Southwest of the Netherlands with a strong regional anchoring and a worldwide orientation. It aims specifically to position itself within the durability, water, safety, innovation and enterprise knowledge domains as a partner to companies, institutes and authorities in order to fulfil their knowledge and innovation needs. In its mission statement the HZ emphasizes its desire to be a community where every person counts and is seen as an individual with a high priority on working together. Because of this, study programs are custom-built to enable flexibility for its stakeholders.

After having developed a custom Virtual Learning Environment (VLE as a part of the DSWE) several years ago and having examined integrated solutions developed by the market, HZ is searching for new perspectives in order to keep up with the demands of its stakeholders. The wish to become a partner to companies, institutes and authorities based on an individual approach combined with IT developments such as social media (as a result of Web 2.0), requires the organization to reassess is current design of it Digital Study and Work Environment.

1.6 RESEARCH QUESTION

To further narrow down the main question, the research question or assignment is as follows:

Design an enterprise architecture to aid the development of a digital working and study environment for higher education institutions taking into account emergent technologies and changing stakeholder needs.

In order to formulate the answer, the research question is divided in the following sub questions:

- ***Is there such a thing as a standard DSWE and if so, how is it designed and what are its guiding principles?***

Research will be done by making an inventory of DSWE's (such as Blackboard) as used by different institutions for higher education and research in backgrounds in the development of DSWE's

characteristics, definitions and intended functions. Since HZ is sponsoring the research, its current DSWE will be used as a blueprint for establishing a typical enterprise architecture in which the findings will be incorporated.

- ***Who are the stakeholders and what are their interests?***

There is a great variety in stakeholders. The aim is to identify them and chart their interests and link these to the findings from the first sub question.

- ***What factors are driving changes in educational institutions and IT regarding the DSWE?***

Research into the environment of institutions with a focus on IT developments, combined with the findings of the earlier sub questions to provide insight in the future requirements of stakeholders and attempt to categorize the findings.

- ***What are current emerging technologies and what is their influence?***

The findings from previous research will be summarized and incorporated in the enterprise architecture as constructed under the first sub question.

- ***What will the future developments for the DSWE be?***

Based upon the findings from previous questions an attempt is made to sketch the future DSWE.

1.7 ACADEMIC RELEVANCE

The findings presented in this thesis have an academic value since it provides insight current and future developments in IT concerning the development of the DSWE and the effects they have on business processes in educational institutes. The study aims to show a shift that is taking place where IT no longer services as a tool to support business processes but where educational institutions need to adapt to the IT its participants are using and how these changes can be adequately dealt with through enterprise design.

2 RELATED WORK AND LITERATURE

This chapter contains a theoretical summary consisting of formal definitions and descriptions of the issues, which relate to the themes of this research: DSWE, relevant emerging technologies and higher education (its characteristics and stakeholders). This allows for a better understanding and analyses of the research data and case study.

2.1 HIGHER EDUCATION

In order to be able to define a DSWE, a closer look is necessary into the environment in which it is placed. Educational institutions are in the business of "selling" knowledge. The following model (Figure 1) based on Porter's value chain (Porter, 1996) represents a typical educational process. A value chain helps to understand the activities by identifying branch specific activities and can be useful as a starting point for further analysis or, for example, with outsourcing issues.

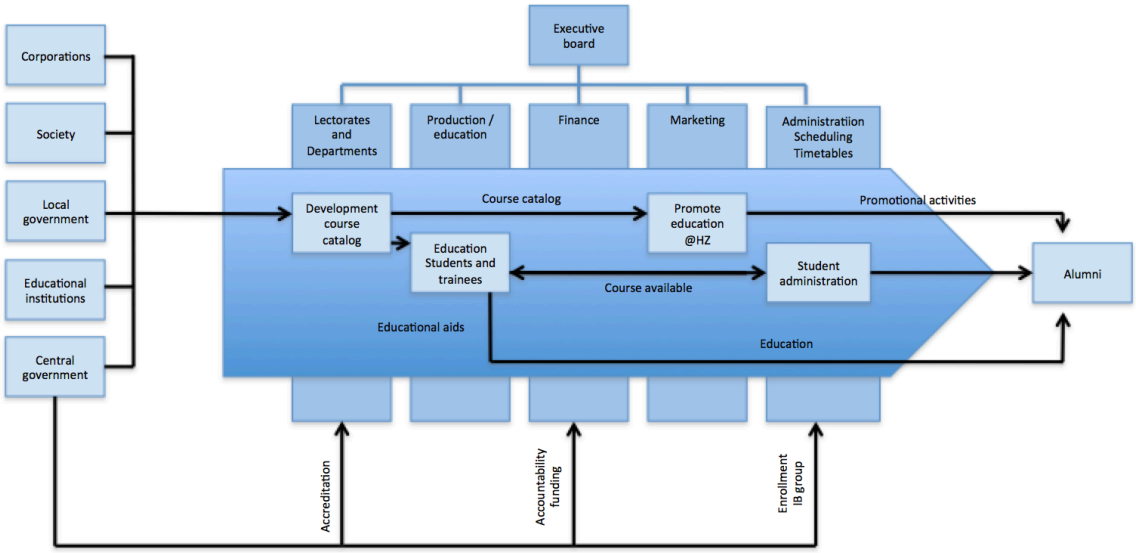


Figure 1: Education value chain.

2.2 DUTCH HIGHER EDUCATIONAL SYSTEM

Dutch higher education has a binary system, which means there is a choice between two types of education programs. Research oriented education, which is offered by research universities and professional, vocational or technical education, which is offered by colleges.

Higher education in the Netherlands provides students with a theoretical education and focuses on practical professional qualifications for higher-level occupations. In addition to lectures, seminars and projects, students are required to complete an internship in their third year. They are also required to complete a research project for their final dissertation at a company.

Research universities include general universities, universities specialized in engineering and agriculture and the Open University. Universities of applied sciences also are divided in general institutions as well as specialized ones. Research universities are however primarily responsible for

offering research oriented programs whereas universities of applied sciences prepare students for specific professions and tend to be more practice oriented.

2.3 Enrolment in higher education

Enrolment is centrally organized through Studielink. Studielink is a product of the Studielink foundation, in which universities closely collaborate with the ministry of Education, Culture and Science (OCW). This governmental controlled website enables potential students to enrol in the desired institution and program. Once they finished the procedure, they will receive confirmation by the institute's student administration as well as through Studielink.

The whole registration process has been automated and institutions are provided with the necessary information such as previous education. Studielink simplifies the whole enrolment procedure for the student and institutions because of the couplings it has with municipal information systems and the national exam registration services (DUO). It also provides useful links for students. Once enrolled the student receives confirmation and the information which is needed to get started.

2.4 The organization of education

The institutions lectorates and departments are (partially) responsible for the development of the course catalogues. These are validated by the Dutch and Flemish accreditation organization (NVAO) whose goal it is to determine and judge the quality of higher education in Flanders and the Netherlands. The main tasks of this governmental institution are assessing and assuring the quality of Dutch and Flemish higher education and promoting the quality of higher education through regular assessment aimed at continuous quality increase. DUO, mentioned in the previous paragraph, is responsible for the funding of the educational institutions and accreditation of diplomas.

2.5 Digital study and work environment

As stated earlier in the introduction, the DSWE in educational institutions represents the total of IT-services, which supports the activities of students, staff and guests of an institution of higher education and research. In the following chapters the backgrounds of a typical institution will be given in order to name the components of a DSWE.

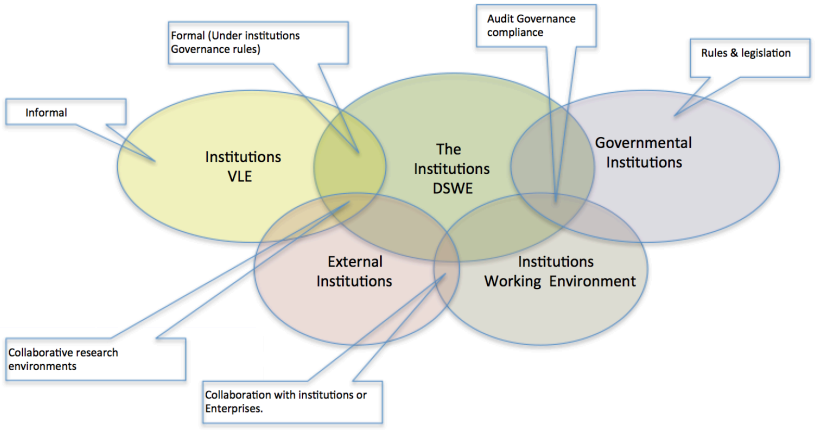


Figure 2: Parts of a Digital Study and Work Environment.

2.6 VIRTUAL LEARNING ENVIRONMENTS

Part of the DSWE specifically supports the educational processes. These are known as the virtual learning environment (VLE).

There are several descriptions for VLE's. They are described as platforms providing interactions between learners and tutors (JICS, 2002) and integrated course delivery systems that provide an environment for the management, delivery and assessment of students studying (Yan et al, 2000).

The supporting processes can be captured under the digital working environment in which all secondary processes are handled such as financial services, marketing, administrative supporting functions and IT. These processes are also referred to as education logistics and include the whole of processes, systems and information flows that allows for the streamlining of the educational process, which together constitute the DSWE. In the following paragraphs a closer look is taken into the developments the DSWE has gone through over time.

2.7 THE EMERGENCE OF THE VLE AND DSWE

The development of DSWE and VLE for higher education can be divided into three generations (Juist, 2011), the classic stand-alone application, the current integrated application and the extended integrated application. These do not represent three separate generations, but states of transformation on which will be further elaborated in the following paragraphs.

2.7.1 THE CLASSICAL VIRTUAL LEARNING ENVIRONMENT

The classical VLE is centred round the teacher. He initiates and organizes the courses with typical actions such as adding student groups into the application and uploading the information and curriculum materials. A typical classical VLE environment enables communication, monitoring and registration.

Typically there are four areas of functionality in the VLE:

- Delivery of content: making available of lesson materials, documents, presentations
- Communication: Enabling announcements, forum, mail and chat functionality
- Administrative tools: enabling "tracking and tracing" to monitor activities and progress
- Digital exams, tests and assessments (summative and formative)

In effect the classical VLE is aiming to be an all in one application where in practice there will almost always be additional or alternative software running to meet more specific demands.

The VLE also has been subject to the development of Web 2.0 tools. As a consequence there constantly are considerations to be made whether or not there are better alternatives available outside of the existing VLE. These considerations are usually made from didactic point of view and may differ per course or program.

For a long time the VLE has been a digital reflection of a classroom with the same characteristics (i.e. limited in functionality and restricted boundaries). The coming of Web 2.0 was partly responsible for the current integrated application we now call the DSWE.

2.7.2 DIGITAL LEARNING AND WORK ENVIRONMENT

Over time the VLE, as decentralized application, has been integrated in a broader environment in which the institutions portal and collaboration environment, as well as systems and applications from the underlying supporting business processes, have been integrated. Students and teachers are no longer the only users of the confined VLE, but an integrated system has emerged which provides in communication and production means for the entire population of the institution. When we refer to a VLE as a digital classroom, we should refer to a DLWE as the digital campus.

The changes in VLE and DSWE are primarily technology driven and as technology progresses questions arise how to incorporate these into the digital campus and what will their influence be on the future DSWE.

2.7.3 EXTENDED INTEGRATED APPLICATION

Based on the overwhelming offer in online applications and services, it is to be expected that a DSWE will be more and more comprised of components scattered within and outside of the institutions whereby users will be offered a wide range in integrated tools of which they are free to make a choice from. Although an institution may choose to cling on to the more classic variants of DSWE or even VLE, the technological developments and progressively more IT-savvy users (especially students) may not stand for it. The question that rises is how the interaction between all these different environments will take place and, maybe more important, will the abundance in educational tools not prove to be an obstacle in the process of teaching?

2006 saw the introduction of the concept of the Personal Learning Environment (PLE) in which the students will create their own personalized learning environment shaped by their individual preferences with the use of (Web 2.0) applications or otherwise integrated (web-) applications. This environment would be partially filled with information provided by the institution in addition to personal applications. In the extended DSWE there could be a shift in responsibilities for the institution and the users (Williams, 2006). Since a part of the information of the DSWE will be scattered around the internet, the institution will not be able to enforce governance over the information. This means users will have to enforce their own governance rules within the terms and conditions that the provider of these specific services maintains.

To further complicate matters, not only will these services be found outside the institution, but also within. Blackboard for instance allows for the possibility to incorporate a mash up which enables the use of outside content within the native Blackboard environment and as such allows for access to the institutions internal IT-infrastructure.

In the following chapter an overview is given of some of the developments that have led to the rise of this Extended DSWE.

3 ORIGINS OF CHANGE REGARDING THE DSWE

The origins for changes concerning the VLE and DSWE will initially be narrowed down to strategic, external, didactic and technical & functional sources.

3.1 STRATEGIC REASONS

Based on the analysis of strategies from OCW and Universities in the Netherlands, institutions need to reach higher study results while the number of dropouts is being reduced and recommends that the current gap between secondary and higher education will also be reduced. Also, improving student counselling / guidance, and intensifying education together with enhancing social cohesion are presented as solutions.

With regards to the DSWE, this can be translated into tools to be implemented which enable closer monitoring and analysis of study behaviour while enabling collaboration between students ensuring involvement and commitment and on the other hand facilitating means of international information exchange and communication. Most important however is the wish for the unambiguous storage of student and educational information and the creation of a less complex architecture of business processes enabling current and accurate management information.

The quality of the primary process of education is largely dependent on the teachers, who are inspired by possibilities new IT developments offer and the influence they have on current didactic methods. The main point that comes forward is how IT has become instrumental in the didactic process enabling the underlying strategic goals.

3.2 EXTERNAL CAUSES

The most common reasons for change occur around the time licenses expire or used products are discontinued. Another aspect, further explored under emerging technologies, is the growing consumerization since users demand better and more diverse services which institutions are not, or only partially, able to deliver.

Another development is the growing interest in open educational resources where institutions make course information and materials openly available through web lectures for example. Even a step further is the possibility to offer complete courses as the Massachusetts institute of Technology or, as a private initiative, Udacity, do.

Changing legislation also has its effects, since accreditation rules are becoming stricter and inspection will be done more stringent. The current trend to outsource (parts) of the DSWE poses a challenge in ensuring the required quality.

3.3 DIDACTIC CAUSES

Since institutions existence derives from their main activity, education, teachers are standing at the forefront improving quality by using new IT developments in their courses and thus changing the IT landscape of the institution. The need to facilitate collaboration between ever growing numbers of students (be it within the institution, across institutions or with third parties) requires teachers to search for new methods of satisfying the didactic needs. From a strategic point of view the institution is expected to monitor the student's progress more closely while the role for teachers is

changing (coach, expert and facilitator). This requires the institution to organize education more effective and efficient.

3.4 EMERGING TECHNOLOGIES

Most publications concerning VLE's refer to e-learning environments, which eliminate the barriers of space and time (Zhang and Nunamaker, 2003). In the following paragraphs relevant developments regarding VLE's are briefly considered.

3.4.1 WEB 2.0

In the beginning the Internet did not consist of more than a Bulletin board service (BBS) that enabled users to share files and exchange messages. The introduction of the hypertext transfer protocol (http), browser technology and network access for the general public during the nineties lead to the rise of homepages. Since 2004 software developers and end users are searching for new ways of using the web. This new Web 2.0 version needed to be flexible and offer the possibility to collaboratively create content instead of the old individual static way. Although the term Web 2.0 suggests otherwise, there were no technical adjustments necessary for the World Wide Web to facilitate the new desired functionality. Instead it was from the development of new applications, that new possibilities emerged such as social media.

3.4.2 SOCIAL MEDIA

Social media are a relatively young field of study and as a result of this, there is no conclusive definition of it to be found. From a communication point of view, depending on the geographical location, there are several different descriptions. The English description adds emphasis on the interactive aspect of social media while the French interpretation in addition indicates a connection with technology, the production of content by users and the interaction that occurs in the process. There is little difference between the French and German definitions, which makes sense since both are based on the publication of Kaplan, and Haenlein (2010). The Dutch description does, however, add an interesting aspect in pointing out the lack of professional editorial supervision with regard to the produce of the users.

Social media and Internet are inextricably intertwined. Kaplan and Haenen (2010) have defined social media as follows; "*Social media is a group of applications built on Internet technology and based on the ideology and technical bases of Web 2.0, which enables users to create and exchange content"*. In Groundswell (Lee and Bernhof, 2008) the authors describe the term groundswell, they coined themselves, as a "*A social trend in which people use Technologies to get the things they need from each other, rather than from traditional institutions like corporations"*. They state this is the result of three forces, man, technology and economics and as such does not represent a trend but an irreversible phenomenon. Because of this, it poses a challenge for institutions to get involved.

In addition it needs to be mentioned that social media do not solely appear as stand-alone applications built around a service, but also as an integrated service within applications. With regards to DSWE and VLE's parts of social media are integrated as web part for instance.

At the time this thesis is being written, 91% of the Dutch households poses one or more computers of which 77% are connected with the Internet through a broadband connection. The average time spent browsing on the internet per month is 25 hours of which 12 hours are spend on social networking sites (or applications). More specific, of the target group of HZ (youths between the age of 16 and 25) 92% are active on Social networks. These statistics illustrate the irreversibility of the current developments.

3.4.3 Cloud computing

Another important development has been the steady increase in bandwidth with regards to networking connections. As a consequence, services or applications no longer need to be kept on premise but can be offered from virtually any place in the world. At this point in time the most well known services are IAAS: Infrastructure as a service, where a vendor offers servers, storage and network connectivity on which the institutions manages the operating systems, databases, security and integration, applications and data. PAAS: Platform as a service, where a vendor manages everything but the institutions manage applications and data. SAAS: Software as a service, where a vendor manages everything but the data. A more recent development is IDAAS: Identity as a service, where a vendor offers a single sign-on as a cloud service.

Cloud computing delivers scalable services through the internet, which users can configure to their own specific needs. This development poses a strategic challenge since students and teachers increasingly make use of the possibilities they offer, whether the institution supports these or not. As a consequence institutions IT departments may need to shift focus from administration to managing services. First and foremost however, an educational institution needs to focus on the internal business processes.

There are, however, some considerations to take into account with regards to cloud services in combination with a DSWE, apart from the consequences for the business processes. What about licenses, privacy and copyright? What about support for the abundance of devices and services that are available?

3.4.4 Mobile devices

In 2008 there was an increase in the number of registered connections of mobile device of 17% compared to the previous year. In 2011 there were more than 6 billion mobile connections registered and the predictions are these numbers will more than double over the next few years (Skaugen, 2011). The emergence of relatively cheap mobile devices with Internet connectivity has led to a shift in the use of standard workstations to netbooks, smartphones, tablets, Ipads, and other mobile devices. Because of their characteristics, mobile devices are strictly personal devices with a reach greater than television or traditional Internet connections; they will greatly influence the way information must be presented.

Terms which originated from this development are ``bring your own device" (byod) and consumerization. The first development refers to the emergence of personally owned mobile devices on the work (or study) place and their usage in accessing company resources. This can mean email but also fileservers, databases and personal data and applications. It is predicted that as a

consequence security will be compromised since devices at the end of 2014 will be containing twice as much malware as is the case now (Gartner, 2012).

With regards to education there is an advantage because it saves on the costs of purchase of equipment and it allows for a higher agility in adapting new technology. As a by-product it also is thought to improve stakeholder productivity (Markess, 2012) since the control of features is given to the user as it allows him to use applications and tools that are not provided by the institution.

Security regulations, however, dictate that private and proprietary information is secure at all times. Combined with the rise of Web 2.0 services, such as Dropbox, this is one of the key issues in designing a new DSWE.

Consumerization concerns the growing tendency for new information technology to emerge first in the consumer market and then spread into business and government organizations, whereas before large businesses and government organizations dominated the early decades of computer development and utilization. At the same time there is an increasing interest in the so-called bring your own device (byod) strategies, whereby employees (and students) are encouraged to bring their own laptop or tablet. These devices are specifically designed for personal use but have proven to be very useful in the workplace. Both developments demonstrate that individual choice and style have become critical factors in the computer industry and, as a consequence, can no longer be ignored by businesses and institutions.

3.4.5 E-LEARNING

Another development in education is the shift from instructor-centred to learner-centred. This approach to education allows for it to be undertaken from virtually everywhere at any time. E-learning, as learning via the Internet is referred to, provides a flexible and personalized way of learning (Zangh & Nunamaker, 2003). However, it seems plausible that this form of education has to deal with the same issues as regular educational institutions.

3.5 SUMMARIZING DEVELOPMENTS

Strategic, didactic and external developments responsible for changes in higher education, be it facilitating or enabling, all hold IT aspects. Most of the emerging technologies hint towards a strongly personalized and more dispersed IT environment in which much of the centralized control mechanisms will not function. This could indicate that security and accountability is no longer a sole responsibility for institutions but a joint one for the organization as well as its participants in every activity they undertake.

The design of the DSWE has an impact on the entire organization and is constantly subject to change, which requires the involvement of all stakeholders and a form of information management that ensures good governance.

In the following chapters a closer look will be taken at the business processes of which the DSWE is comprised and the consequences for governance.

4 BUSINESS PROCESSES CHARACTERISTICS AND STAKEHOLDERS

With regard to the evolution of the DSWE and the developments described in the previous chapter, an overview can be given of the business process characteristics of an educational institution through an activity map clarifying interdependencies.

Based on the findings from the previous chapters, there are four domains defined within an educational institution. The first domain concerns the primary business process of learning and teaching where the interaction between teachers and students takes place. Here teachers organize their teaching in courses and modules that utilize the DSWE infrastructure. The second domain is the educational organization, which organizes education by guarding mutual coherence between the modules as part of the course and the interrelationships between courses as professional practice and scientific insights progress. The third domain is formed by the educational logistics where all disciplines that aim to facilitate the educational process are embedded within the institution. The technical infrastructure is traditionally placed within this third domain together with other supporting services such as commissions and policy makers. The fourth domain concerns the institution itself where its board defines (meta) policies concerning education and infrastructure and its financing.

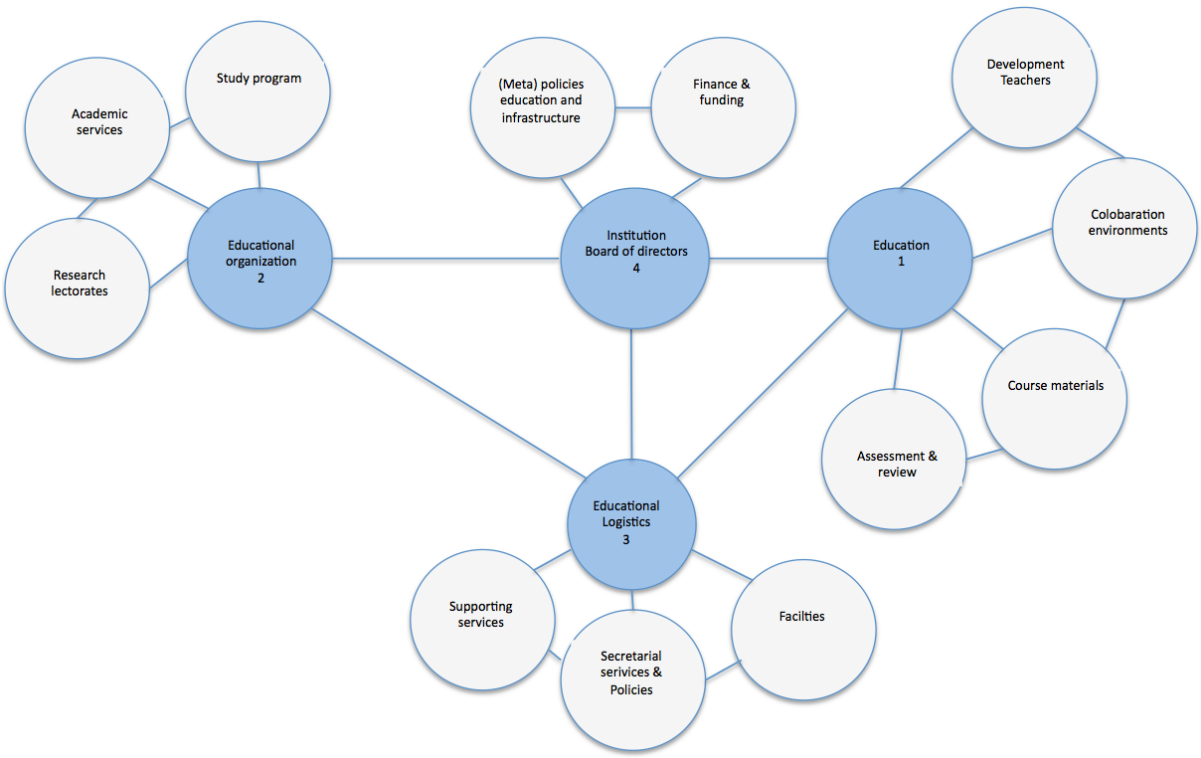


Figure 3 Activity map education

Activity maps show an institution strategic position by identifying sets of activities, designed to deliver the desired strategic goals. In institutions with a clear designed strategic position, a number of higher-order strategic themes (Highlighted in blue in Figure 3 Activity map education) can be

identified and implemented through clusters of tightly linked activities. (M. Porter, Harvard Business Review, 1996).

Quality of education is largely dependent on the quality of the supporting business processes (SURF Scientific Technical Council, 2008). It is not hard to enforce standardized application supporting these processes, since it does not make sense to use two different financial or timetabling applications. The applications used in the educational processes, however, will differ depending on audiences, course and culture as well as on the used method of teaching. Especially the teaching method holds great consequences for the DSWE. To sum up just a few, there are action learning, project learning, classes, labs and practical assignments, seminars, workshops, internships, etc. All these forms of education demand different applications for support and assessment, which require great flexibility to control the diversity.

As the activity map visualizes the four domains and also gives an insight in the activities and organization of the institutions (internal) stakeholders, the question arises what distinction can be made between the stakeholders and how information is distributed throughout the institution.

SURF in more detail: SURF is the name of the ICT organization of the cooperating institutions of higher education and research in the Netherlands founded some twenty years ago. Their aim is to work together in achieving ground breaking ICT innovations in order to improve the quality of higher education and research. Surf focuses on several different themes by accumulating knowledge and activities per specific area. Current themes are; Digital Rights, Open Research, Cloud computing, Network Infrastructure, Security and privacy, Innovation in Education, Organizing with ICT, Green ICT and Collaboration Infrastructure. Experts from institutions for higher education are working together on the theme of their respective expertise in Special Interest Groups (SIG's)

Supplementary to IDAAS: With regards to higher education in the Netherlands, SURF Federation has started an initiative in 2006 whereby users can access certain third party web-applications with the use of the user account their institution has provided. This development was followed by SURFConext, which incorporates the federative authentication possibilities (2012) and combines the option to manage group memberships in order to be able to create collaboration sites (either with or without intervention of the institutions involved). This service could be considered as Identity management as a service. Based on middleware, supported by federative technology and concepts from Social networks, it enables access to cloud services from third parties in a controlled and safe manner with the use of the user accounts issued by the institutions themselves enabling a uniform common foundation for online collaboration in higher education and research in the Netherlands.

4.1.1 STAKEHOLDERS

Based on Figure1 there are several parties that influence educational institutions. A more general subdivision can be made by dividing stakeholders in macro, meso and micro levels. Where macro level concerns the outside of the institution (international, national and societal organizations, such as government, and the professional field responsible for determining the framework for higher education). Meso and micro levels involve the institution itself, representing higher education management, responsible for management of the institutions and the participants such as course developers, teachers, staff and students, responsible for the educational process / learning.

All stakeholders on each level have different interests and as a consequence different (often conflicting) views on quality and the related performance indicators. A more detailed subdivision will be given in the case study. However, this indicates that the DSWE needs management in which the different stakeholder groups participate, in order to create the desired governance, which assures the coherence and consistency of the DSWE. Based on the four domains from the activity map (Figure 3) there seems to be little collaboration between institutions regarding the macro level as far as the development of the DSWE concerns, with exception of the SURFconext initiative by SURFnet. The focus for the new DSWE needs to be aimed at the stakeholders on meso and micro level. In order to see how this works out, a closer look has to be taken to the way information is organized.

4.2 Distribution of information throughout the DSWE

In its report concerning future developments in the DSWE[1], SURF uses the metaphor of a medieval fortified city, where the castle represents the heart of the information landscape of the DSWE where all crucial information is stored and safely guarded by security mechanisms. Outside the castle, but within the fortified city walls, there is relative safety enforced by the lord of the castle since there is only marginal supervision on activities as long as these adhere to regulation. Finally there is the vast outside world on the other side of the city walls, which conceals many dangers as well as great freedom and opportunities. Everything that is placed outside the walls of the castle falls under personal responsibility (Figure 4).

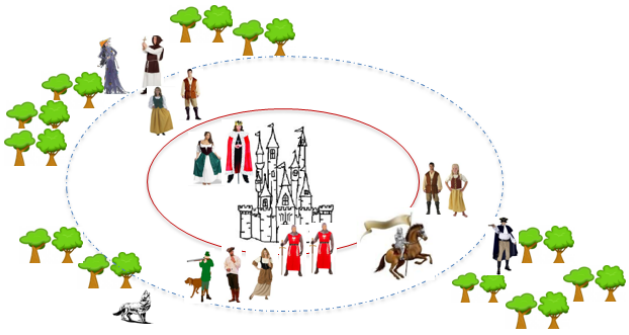


Figure 4: Early design of a DSWE

Cloud computing with regards to this metaphor seems to be a golden opportunity since it greatly enhances the way people would go about their affairs but only outside the safety of the castle walls, thus challenging security and autonomy, rearranging the “natural order of things”.

An analysis of the strategies from the ministry of OCW and strategic planning documents from universities shows there are several reasons for redesigning the early DSWE. First of all study efficiency has to be improved by better connecting secondary education and higher education. Improving tutoring, offering more flexibility, intensifying education and improving social cohesion can achieve this, raising effectiveness and efficiency. Also institutions need to improve their

[1] *Ontwikkelingen in de digitale leer en werkomgeving van het hoger onderwijs*. Publication SURF, (2012).

international orientation and promote cooperation between national and international knowledge institutions.

The new DSWE can contribute to these strategic goals by enabling better possibilities for monitoring study behaviour and progress and storing student and educational data unambiguously and at the same time unify educational processes in a coherent architecture of processes and information systems thus enabling correct and coherent management information. This can be partly achieved by incorporating new technologies to enable better cooperation between students and teachers and setting up IT support for education and research in an institution transcending way as proposed by SURFconext, increasing flexibility by decreasing the need for time and place bound education.

Higher education has a strong connection with the professional field, which means there has to be a connection with the outside world from the perspective of the DSWE. On the one hand this means external entities need to be able to connect and access data they are authorized for and on the other hand information, which is publicly available, has to be made accessible.

So how will information in the new DSWE differ from the old?

4.2.1 Conceptual data model

Based on the general subdivision of the new DSWE we can make a distinction in three categories of information. Firstly, there is information necessary for the organization of the educational logistics. This information is present in, for the most part, different linked systems such as roster and resources applications, course information, course and exam administration.

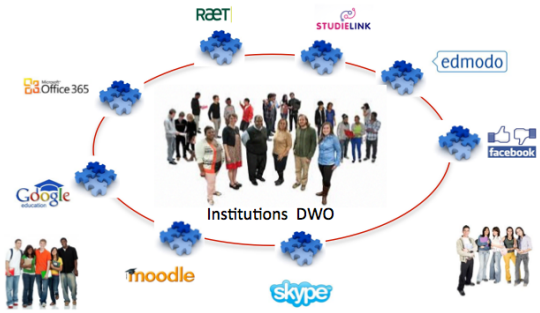


Figure 5: Future design of a DSWE

Secondly, there is information deriving from secondary processes. This concerns the information that comes forth from policymaking, projects, budgets, concept plans, etc. For the most part this information is recorded in documents made with an office suite or other application and filed or stored on generic shares without structure or metadata. This type of data has a tendency to duplicate and drift through and outside the institution. Thirdly, there is information deriving from primary processes. This information results directly from the primary process and can take many forms varying from videos on YouTube to documents saved somewhere online. When it comes to accreditation this information is vital in establishing the quality of the education.

On the one hand there is data, which is produced by students in online collaboration environments and on the other hand the course materials, which need to be distributed. In addition there are the items needed for assessing quality and progress of the students. Here also data has a tendency to

float around. There is however a moment upon which the produce of information needs to enter the IT environment of the institution and be secured in order to comply with quality requirements.

Since the DSWE is considered a construct of different systems there is a difference between the systems supporting educational logistics and the systems in the virtual learning environment that supports the primary process (i.e. the transfer of knowledge, education itself). The data model for educational logistic systems tends to be integrated in the form of databases that are interconnected in order to enable the exchange, linking, synchronising or publishing of data. The better the integration, the better information can be personified and offered to the end user. As a consequence, applications supporting educational logistics are usually standardized and embedded in the institutions workflows with a form of quality assurance guarding the process.

On the other hand the VLE does not allow for such a rigid construct since the execution of education can take many forms (projects, college, labs, self-study programs, etc.), not to mention the relation with the professional field, businesses, other institutions, etc. who also need access to the VLE or may need to arrange access for students to external (collaboration) environments (Figure 5).

Standardization in DSWE: The Blackboard institute is the current industry leader with 20 million daily users from 850 institutes among which 15 million students. They offer an array of integrated services through several applications that allow for the integration a variety of (third party) applications. Although integration of social media is allowed for, the application has to be placed within the framework Blackboard provides. In practice, however, students (and teachers) will not have themselves confined to the surroundings of an institution DSWE for their communications or collaboration with peers and teachers, thus leaving institutions with a very expensive application filled with functionalities users do not use. This leaves the question whether institutions should only invest in functionalities in which it can distinguish itself from other institutions.

In order to stay in control of the data deriving from the primary and supporting processes, governance plays an important role. This will be further explained in the following paragraphs and further elaborated on in the case study.

4.3 Governance and the DSWE

As stated earlier, the overwhelming offer in online applications and services within range of increasingly IT-savvy end-users and variety in stakeholders for the new DSWE dictates adequate control in organizing the information, thus requiring a closer look into IT governance and the way this is embedded in the business processes.

The DSWE has an impact on the entire organization and as a consequence requires support from the entire organization. Relevant stakeholders need to be included when changes in the different domains are discussed. Since these changes effect the primary and secondary business processes, there is a need for a structural relation with stakeholders. This can be achieved by implementing information management in order to shape, guide, adjust and maintain the provisioning of information.

IT –Governance is the way in which an organization guides and funds its IT activities so that planned improvements or goals are actually achieved. The aim for this study is to use enterprise engineering

and enterprise architecture (Hoogervorst, 2009) in order to achieve an integrated architecture with a focus on the whole of the organization.

Hoogervorst's views are based on two themes. Firstly the competence based perspective on governance whereby employees are viewed as the crucial core for effectively addressing the institutions complex reality by defining and operationalizing strategic choices. The second theme concerns enterprise engineering as a conceptual framework for arranging a unified and integrated enterprise design as a necessary condition for an institutions success.

Enterprise architecture is defined as a coherent and consistent set of principles and standards that guides enterprise design. The main design domains are Business, which concerns the institutions function, Organization that guides the organizational arrangement through principles and standards, Information, which handles the use of information and fourth and last Technology, which guides IT system design.

What distinguishes Hoogervorst, is the way he approaches governance from an organismic perspective, resting on the creative and intellectual capacities of employees (or students for that matter). Only through their different perspectives institutions can effectively address the complexity, dynamics and uncertainties that confront them, avoiding strategic failure.

4.3.1 GOVERNANCE AND ENTERPRISE ENGINEERING

There are three kinds of governance to be distinguished that are interdependent (Hoogervorst, 2009). Corporate governance, covering the whole of in- and external rules and legislation aimed at control and risk management in order for institutions to effectively comply with their responsibilities towards their stakeholders. IT governance, translated in the organizations competence needed for the continuous execution of guiding authority over IT-strategy and architecture development and the design and implementation of IT-systems in the operation. Enterprise governance, finally, concerns the operations competence for the continuous execution of guiding authority over the organizations strategy and architecture development and the implementation within its organization. Or more simply put: the coherent whole of organizational skills, knowledge and technology embedded in the competences of the employees.

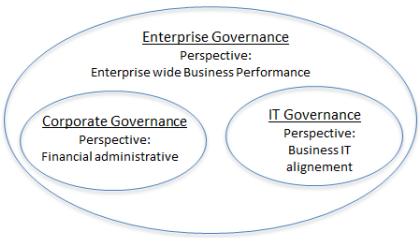


Figure 6: Governance interdependencies

Between the different forms of governance there exist interdependencies (Figure 6). IT, for instance, is used for the transactional system concerning data entry and reporting but also overlaps with security management, identity management, data management (and data integrity) which are aspects of corporate governance, which implies an overlap between corporate governance and IT governance. The link between corporate governance and enterprise governance consists of the interplay between the two. The portfolio of products and services and business model reflect the

internal business logic on the basis of which economic value is created. The governance model not only gives aim to the development of the portfolio but in turn also shapes the organization that produces the products. Particularly applicable to this research is the link between IT governance and enterprise governance since IT supports (future) enterprise goals, but in order for IT to truly have an effect on an enterprise, IT needs to change the enterprise itself (Parker and Benson, 1998).

Design is paramount in addressing these joint relations between the governance topics. A uniform approach is necessary in addressing the shared governance topics. The guiding perspectives from Enterprise Governance address this approach. Hoogervorst refers to this with enterprise competence as the whole of skills, knowledge and technology of an organization, which gives guiding authority over enterprise strategy and architecture developments. This means it influences the underlying design of the enterprise and the implementation and management of the enterprise ensuring the three forms of governance are shaped in an unambiguous way.

Since governance guidance is needed in order to effectively implement strategy in a consistent and coherent manner, Hoogervorst defines three disciplines. Enterprise engineering, which is concerns the body of knowledge, concepts, theories and methods, for analysing, designing and creating organizations leading to the desired enterprise architecture, a coherent consistent set of principles and standards that gives direction to the design of an entire organization. Enterprise architecture provides normative guidelines for design, aimed at having the organization operate as a unified and integrated whole, realizing the goals of the enterprise. Enterprise design is subsequently defined as a sequence of actions aimed at changing the existing organizational conditions into the desired ones.

Within an institution there are four design domains (Figure 7) for which architecture can be designed that guides the structure of the domain. These domains are business, information, organization and technology. As far as this research paper is concerned, the emphasis lies on IT-governance while taking in account the interdependencies with corporate and enterprise governance.

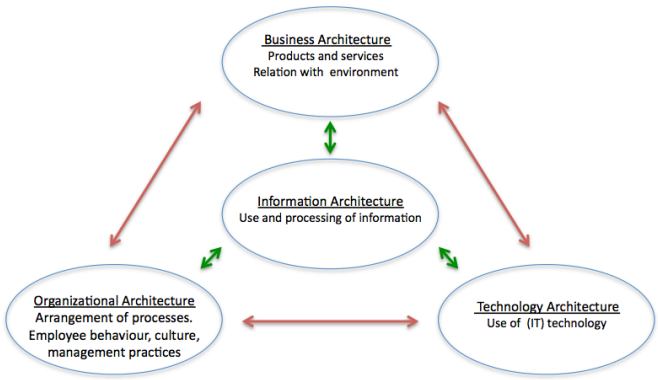


Figure 7: Design domains in enterprise architecture

Potential problem with regards to this approach is that the institutions governance is confined to its organizational boundaries. The extended integrated DSWE, however, transcends these boundaries, creating a gap. As the boundaries of an institution become less obvious, so will the governance agreements and a need for additional rules arises. This issue will further be addressed in the elaboration of the research and case study.

4.4 SUMMARIZING CHARACTERISTICS

Based on the information gathered so far, the evolution of the DSWE and VLE shows, there is no longer a focus on groups in a confined environment, but a strong orientation on the individual and individual freedom while supporting a growing number of devices and applications requiring new ways in presenting real-time (personalized) information.

Because of the dynamics in both education and technology, flexibility is a vital attribute to success. This could indicate a break from traditional Enterprise applications such as Blackboard, which hang on to a single integrated environment for educational logistics and Virtual Learning Environment since the desired features of these environments may differ depending on course, requirements or form demanding an open structure and as such next to impossible to standardize.

As the emphasis shifts from a controlled on premise environment with a focus on applications and features to a hybrid IT-infrastructure with a focus on informational aspects and the wish for more collaboration between institutions and collaboration transcending educational institutions, changes in governance requirements will be necessary, as well as a need for a form of identity management (or even provisioning) transcending individual institutions. Security and accountability seems to be no longer a sole responsibility for institutions but a joint one for the organization and its participants in every activity they undertake.

4.5 PRELIMINARY FINDINGS

Set against the research questions, some preliminary findings can be made with regards to the definition of a Digital Study and Working Environment. The Dutch Scientific Technical Council gives the following description: The Digital Working and Study Environment (DSWE) represents the total of IT-services, which supports the activities of students, staff and guests of an institution of higher education and research (WTR, 2010). This definition will be used as the reference framework for the case study.

The design of the DSWE has been subject to several changes, mostly caused by technical innovations and trends. The guiding principals were initially based on the advance of learning in a supporting role (i.e. applications aimed at supporting the curriculum). There is a growing conviction however, in order to achieve excellence in education, the supporting processes have to be aligned in order to allow for a better focus on education. The second however does not exclude the latter, rather than it hints to the development of better integration with the institutions environment.

The guiding principles for a DSWE are the delivery of content, communication, administration and collaboration and taking these in account it can be put forward that the standard DSWE exists but, because of continuous technological advance, subject to constant change. Based on the direction industry leaders, such as Blackboard, are developing their applications, there is a focus on cloud services but still from an integrated (enterprise) application standpoint in which, regarding the guiding principles, the classical functionality is still incorporated.

The current design of the standard DSWE and changes influencing its design leads to conflicting interests between staff (secondary process) and teachers (primary process) and between the both and students. Through the activity map it seems most institutions are strongly hierarchal

organizations in which information provisioning is a utility service, which follows business decisions. This would explain that, from a collaboration point of view, there are few initiatives to align information other than an initiative from SURFnet trough SURFconext.

There are several factors driving change in educational institutions. These can be divided in strategic, external, technical & functional and didactical factors. The strategic factors aim to reduce the gap between secondary and higher education by improving student counselling and guidance, intensifying education and enhancing social cohesion. With regards to the external factors emerging technologies and changing stakeholder demands and expectations are leading to a need for a more service-oriented approach. Examples of these developments are the growing interest in open educational resources, consumerization and byod. This is at odds with legislation becoming stricter and more stringent inspections regarding accreditation of educational programs.

With regards to how this all affects the DSWE, this can be translated into an abundance of tools to be implemented which enable closer monitoring and analysis of study behaviour, collaboration between students ensuring involvement and commitment and facilitating means of international information exchange and communication. Most important however is the wish for the unambiguous storage of student and educational information and the creation of a less complex architecture of business processes enabling current and accurate management information

From a didactic point of view teachers are standing at the forefront improving the quality of education by using new IT developments in their courses. This requires teachers to search for new methods of satisfying the didactic needs and improving ways of monitoring student progress. At the same time education needs to be organized more efficient and effective.

Strategic, didactic and external developments responsible for the changes in higher education, be it facilitating or enabling, all hold IT-aspects. Especially Web 2.0 applications are revolutionizing the deployment of educational applications and the IT landscape of educational intuitions. Most of the emerging technologies hint towards a more dispersed IT environment in which much of the centralized control mechanisms will not function.

Common aspect of IT developments is the use of web-enabled applications combined with a growing variety of personal devices enabling access any time from any place to information. Because of the dynamics in both education and technology, flexibility is a vital attribute to success. Since the design of the DSWE has an impact on the entire organization and is constantly subject to change, it requires the involvement of all stakeholders, preferably, guided by a form of information management that ensures good IT-governance.

Now “the walls of the castle are crumbling down” as demands increase for collaboration transcending the institutions and personalization of applications and hardware, new ways have to be found to ensure compliance to rules and regulations concerning privacy and the protection of the institutions “crown jewels”.

Based in part on the developments by industry leaders, it is to be expected there will be a further integration of Web 2.0 services in the existing applications, allowing for a more flexibility (or for a better word; leniency). The guiding principles however will not be changed. Because of the

developments in Web 2.0 applications, the prediction of personalized Learning Environments for students, whereby he institution provide the information through wiki's, apps or widgets either developed by third parties or the prosumers themselves is in line with this development.

The term prosumers refers to the blurring gap between producers and consumers. Increasingly consumers are co-innovating and co-producing the products they consume. Prosumtion goes beyond product customization since it entails earlier and deeper engagement in the design process and production, sharing product related information, tools and tips and collaboration on customizing products (Tapscott, 2008).

5 CASE STUDY

HZ considers IT one of the core processes of the organization. Current in- and external IT developments are included in the annual revised IT strategy plans based on the institutions strategic plans. Before getting into the specifics of IT, more general information is provided to clarify the context in which the IT strategy is formed.

5.1 MISSION, VISION AND VALUES

For any institution mission, vision and strategy legitimize their existence and represent the choices it has made concerning future endeavors. The core values, which have been formulated alongside mission, vision and strategy, are meant to be guiding the organization providing balance between attitude, rules and behavior. Together they form the context for the organization. In the following paragraphs HZ's choices will be described in order to clarify the context for this case study.

HZ University of applied sciences is a knowledge institute with strong ties in the region and a worldwide orientation. It aims to position itself within the knowledge domains of durability, water, safety and, innovation & enterprise. Mastering the chosen competences is achieved through custom made education, aimed at a lifelong career in a multicultural and multiform society. HZ wants to be a partner to companies, institutes and authorities in order to look after their every knowledge and innovation needs.

Characteristic for the HZ, as an independent knowledge institute, are its entrepreneurial attitude and market oriented education and research with a firm regional base and international orientation. Because of its small scale, HZ encourages student involvement and commitment with their education stimulating engagement and in doing so developing student's talents.
HZ, in cooperation with the international professional field and by offering excellent and challenging training, delivers responsible and valuable professionals for a globalized workplace.

HZ wants to be a community where every person is seen as an individual, where working together is high on the list of priorities and where there is mutual respect for the development possibilities of all involved. To achieve this goal, HZ has defined three main or core values to which employees have to abide, the first being involvement; HZ employees are responsible for the tasks, which they are assigned and will account for these tasks unsolicited. They are aware of the constant changing and further globalizing environment in which the institution resides. HZ employees are highly motivated with a passion for their profession and well aware they can only realize HZ's mission and vision through collaboration. The second core value is quality since this is essential to everyone at HZ. Quality in education, as well as quality in communication with students and other stakeholders, helping others to develop and improve themselves by sharing knowledge and collaborating. Knowledge is not only shared with students but also with businesses, industries and governments through various forms of education and research. Quality at HZ also includes the constant aim to produce results at the agreed upon times. This way quality manifests itself in high academic results, satisfied students and a high level of practicality of the research. Thirdly integrity and respect form the last of the core values. Because of the high level of involvement and integrity, a remarkable educational environment is created through which HZ distinguishes itself from other institutions for higher education. Mutual respect and trust are the keywords in maintaining this environment.

5.2 STRATEGY

The strategic agenda resulting the mission, vision and values environment is further drawn out below.

5.2.1 PERSONAL INSTITUTE FOR HIGHER EDUCATION:

HZ chooses to fulfill the role as a regional institution by being a personal institute for higher education for the region of the southwest of the Netherlands. Specific goals and values are making the top ten of Dutch institutions for higher education with regards to student satisfaction (based on the selection guide higher education) and a minimum accreditation rating of “good” on selected aspects of educational programs. Also HZ whishes to maintain its core values as guiding and determinative in behavior for everyone connected to HZ and hold them accountable for compliance to these values.

Studying is for the most part an individualistic occupation. This personal process is warranted through working based on the values HZ has adopted. Because of the small scale on which HZ operates such an approach works well. Starting with a personal introductory meeting throughout the program there is an emphasis on academic counseling aimed at developing the talents of the student. Because of frequent personal contact between student and teacher the courses are inspiring and intensive.

5.2.2 KEY PLAYER FOR THE REGION

Because of its unique location in the southwest region of the Netherlands, HZ plays a crucial role in the fields of education and research. HZ has set as goals to become one of the most important knowledge partners for the region Southwest of the Netherlands and expand the current number of educational locations. Within the context of “lifelong learning”, new and innovative forms of courses (part-time, modular or dual) will be developed. The newly enrolled students (working people) must make up for 20 percent of the total student population of the institution.

HZ fulfills a crucial task according to her stakeholders in the region as she is developing from an educational institution to a knowledge institution. An indispensable part of HZ as a center of expertise is the applied research in core areas. These are water, energy, care, work and tourism, which are all directly linked to needs in the region.

5.2.3 PARTICIPATION STAKEHOLDERS

Stakeholders are actively involved determining the policies of the HZ. A special role is reserved for partner educational institutions in the region with which collaboration exists in the fields of educational and research aiming at efficient and effective management of external networks, an above average appreciation amongst the stakeholders concerning the related courses and programs and a positive image for HZ in the region of the Southwest of the Netherlands.

HZ has identified her stakeholders in the region, such as educational, governmental and business institutions, and contacted them in order to exchange ideas on how to build a beneficial lasting relationship. In order to further develop these relationships coordinators managing these relations have been appointed and alliances have been formed for the purpose of dual education and applied research.

5.2.4 DELTA AND TOURISM AS (INTER-) NATIONAL NICHE PROGRAMS

Aside from a broad regional function, HZ focuses on several niche programs, which are to attract national as well as international students. These programs are coupled to practical research and regional issues with an international impact and appeal. The southwest of the Netherlands is pre-eminently suited for research regarding living and working in a delta as well as tourism. The programs include coastal protection, water treatment and delta engineering.

HZ aims to broaden the horizon of their students by focusing on international economical, technical and social issues. One of HZ's goals is to have 10 percent of HZ's students be international students and 2 percent of its students are exchange students. Students and employees must be aware of important developments on an international level with regards to their professional field. Furthermore HZ will form alliances with international partner institutions, try to attract international teachers and attempt to attract foreign students who can contribute to the internationalization of national students.

5.3 REFLECTION ON STRATEGY

The current strategy has been held against a strength & weaknesses analysis (SWOT analysis) and environment analysis in order to clarify the opportunities and threats of the HZ. SWOT and environment analyses are business management tools to aid and assess strategic positioning and evaluate competition, organizational development, product development, research and teambuilding. Based on the outcome it can be determined whether the HZ's strategy matches the findings of the research. A summary of the findings is given in the following paragraphs.

5.3.1 HZ'S ANALYSIS ON STRATEGY

HZ University of Applied Science is the sole provider for higher education in Zeeland, offering unique courses that are specific for the region. Because of its small scale HZ is able to maintain personal contact with her students resulting in high quality interaction and teaching (as indicated by results in national surveys).

There are however also some problems. The current ICT infrastructure regarding the DSWE is out-dated and HZ is struggling with trends as cloud services, consumerization and byod. Also, cooperation with industry and other educational institutions in the region is relatively hard to accomplish. Previous attempts at cooperation in various fields with regional secondary education institutions have proven to be infeasible as well as costly.

There are plenty of opportunities for HZ. The demand for training on innovation and sustainability allows for the development of new courses. The unique characteristics of Zeeland makes courses such as Aquatic Eco-technology and other specialized programs very attractive to students. Initiatives launched by government such as "lifelong learning" and the introduction of Experience Certificates based on prior learning (EVC's), provide opportunities for the development of training for new audiences.

The aging of the population forms a slowly progressing threat for HZ since this development affects the quality of the teaching staff of HZ. The outflow of teachers the coming years makes it

increasingly difficult to attract good teachers in Zeeland. Besides that, the Schutte-claim still constitutes to be a heavy burden for the HZ, making it difficult to invest in all the necessary areas.

In 2005 the findings of an inquiry into fraudulent actions by institutions for higher education were published in the final report of the commission Schutte. This commission was established in 2003 in order to lead a parliamentary inquiry following allegations stated by a whistle-blower, claiming educational institutions were tampering with student registrations and engaging in commercial activities in order to artificially raise the number of enrolled students, thus receiving more funding. The commission estimated about 96 million euro's were unlawfully claimed and should be reclaimed from the institutions. HZ, unfortunately, was one of the culprits and was summoned to return 19,1 million euro's over a period of 20 years.

5.3.2 HZ'S ANALYSIS ON ITS ENVIRONMENT

Zeeland faces a number of demographic problems. First and foremost there is the ageing and declining population combined with an on-going exodus of youths. For the HZ, the influx of students and attract good teachers and employees are of the utmost importance. This is further being complicated by the current economic situation, which hinders willingness to invest in training, collaboration and opportunities for innovation. Adding to this the Zeeland small-scale culture leads to a readiness for cooperation but in practice seems to be strongly focused on the interests of the own institution, organization or constituency. There seems to be a lack of sense of urgency, collective ambition and an institution transcending guiding policy hindering cooperation.

As stated earlier in the SWOT analysis, HZ University of applied sciences is the only institution of higher professional education in Zeeland with the nearest college to be found in Brabant. Some of HZ's training programs, such as the one for maritime officer, are only given in a few institutions in the Netherlands, giving HZ a competitive edge. With regards to ecology, an increasing focus on innovation in the field of nature, environment and sustainability leads to the demand for the development of new programs.
Political decisions at national level regarding educational institutions and students have had great consequences for HZ's strategy. Institutions are to offer a less broad range of programs and are required to offer specialized courses in which the institution has acquired unique knowledge and resources. Another effect of the influence politics have on institutions is the pressure on students and institutions to have students complete their studies within the given time span.

With regards to technological developments, the greatest challenge for the near future for HZ is connecting to and collaboration with partner organizations, industry and other parties making ever-higher demands on availability and integration of ICT systems with other parties.

The SWOT analysis and environment study in relation to the business strategy indicate that the HZ is well aware that for its survival, it needs to look outside the boundaries of the organization and those of Zeeland. Its weak financial position, demographic conditions and "Zeeuwse" culture are the bottlenecks that need closer consideration.

5.4 IT-STRATEGY

The IT strategy is primarily determined by the Department of Information services and Automation and set in the Information services policy plan papers. Whereas policies were usually determined for a period of three to five years, the current policies are determined for a period of a year because of the pace in which changes are taking place and new developments occur. For HZ the following spearheads are defined:

Web, Web, Web
As is the case according to real estate brokers, stating the three main points for a home location, location and location, the HZ suggests that the role of the Internet is not be underestimated.

Self (Self) where possible
An important principle in both the information provisioning and the organization of the HZ business processes is self-service. One argument for this approach is that it ties in with what students are already used to in for example banking and Internet shopping. This way a high degree of efficiency in business processes can be realized because a part of the administrative burden is shifted from the institution's administrative services to the student. This has profound implications for accessibility (Any Place, Any Time, Any Device) and usability of information systems that are to support this self-service.

Applications per domain (Best of breed)
Despite the institution's need for integrated information HZ has chosen for implementing specific applications for the various business processes of the HZ. This implies a "Best of breed" approach instead of a comprehensive Enterprise Resource Planning (ERP) system. Main reasons for this approach are the high costs and lack of flexibility in most ERP systems as for example the Gartner Group has indicated.

Integration of information
There is a great need to satisfy the demand for integration of information. Because of the mentioned "best of breed" approach, HZ has opted for integration through a central database. This central database (Data warehouse) is a central point for both the data from the various underlying information systems and the exchange of data between these information systems. Such a model fits in a Service Oriented Approach (SOA) in which information systems are increasingly seen as systems that provide a particular service resulting from so-called Enterprise Service Brokers, which are able to communicate with other applications. A high level overview is given in Figure 8.

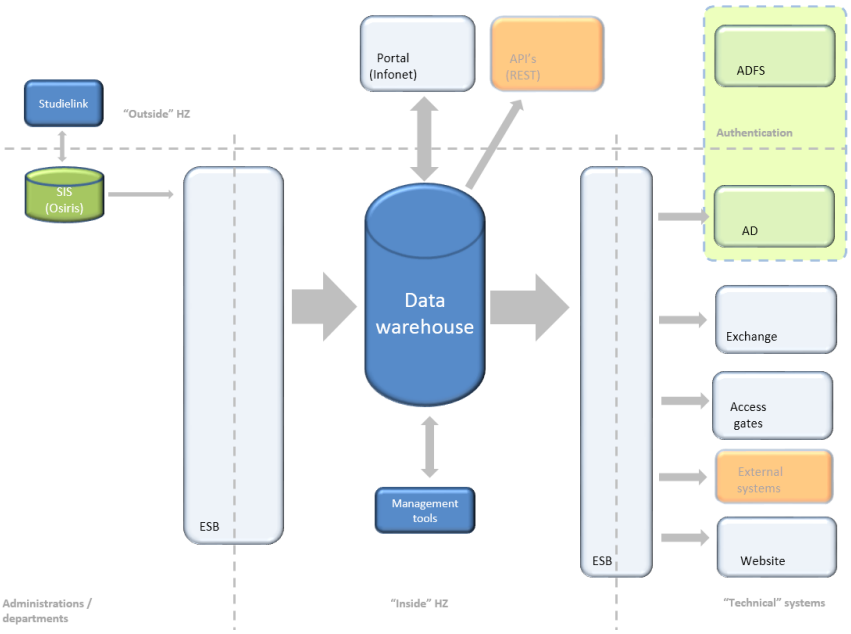


Figure 8: Data integration through data warehouse

SOA, a short digression: "From an organizational perspective, the concept of SOA covers a very broad area. The starting point is the integrated support of the business processes. The business processes are built from services offered by different professional disciplines within the organization from which ultimately the produce is delivered through automated services to the customers. The services, out of which the business processes are constructed, correspond with the services supplied by information systems, thus allowing the services (in the technical sense) to represent themselves as a mirror image of the services of which the business processes are constructed (Kruiswijk, 2010).

HZ SOA in practice (Figure 8**)**

When a student enrols through Studielink, automatically through a service broker the information is passed on to the student information system (SIS). Because of the changes in the database, a service is triggered which will enter an entry in the financial systems (not shown in overview) for the student and at the same time an account will be created in the Active Directory together with the creation of an e-mail account, entry in the access-gates database, allowing them to drive their car on to the parking grounds and a plethora of other systems. The new account will however not be unlocked until the collection authorization has been cleared in the financial system.

Since the (prospect) student is now a known entity for the HZ a beginning can be made with assembling the study program and subsequent planning groups. This is done through management application (Mycoach), which is directly linked to the data warehouse, which in turn has couplings with the rostering program (Syllabus) thus ensuring the integrity of the data. Once the rosters have been established, the data is incorporated in the data warehouse where personalized information is stored, triggering a service that synchronizes the information with the personal agenda of the user in Exchange, which in turn allows for connectivity with a variety of devices and operating systems.

Because the information architecture takes the workflow and business processes as a starting point and the underlying applications are subsequently arranged, which are based on open standards, combined with the use of a broker and subscriber systematics, the time between enrolment in Studielink and the provisioning of identities is question of minutes.

Educational process is a chain of business processes

The educational process and the organization around it is, as a result of the increasing diversity of students and the need for ever greater flexibility, becoming more and more complex. In order to cope with the complexity, a process-oriented approach is needed, meaning that the aim should be that all parties in the HZ are aware of the fact that their actions affect other processes within the HZ. All the business processes around and within HZ form a chain of which the strength is determined by the weakest link.

Transparency of organization and processes

Transparency is important in the design of information systems. A high level of transparency makes it possible to change the process of authorization within information systems making it less rigid. When actions from stakeholders are visible, they will engage in dialogue with each other and, as a consequence, authorization will be taking form through consultation, rather than management enforcing systems. Moreover, it is easier in case of an emergency for people to take over each other's tasks. Organization of tasks combined with a fairly broad authorization structure results in a high degree of transparency which will not be possible when an institution chooses for strict authorizations, thus effectively "boarding up" the divides between stakeholders.

Future-proof flexible IT Architecture

Based on the earlier position on "best of breed" HZ has chosen to adapt Microsoft as platform for its technical infrastructure. The reason for this lies in the fact that a majority of applications has been developed based on their technology. HZ's own development of software is also based on Microsoft development tools and ensures optimum integration with the target Data Warehouse and at the same time with external parties (applications as well as services).

Introducing sockets

In order to be able to handle the current developments with regards to consumerization and byod HZ aims to unlock information by means of "sockets" through which, independent of device or operating system, users can receive personalized information to which they have access. An example of this approach is the way rosters are synchronized in real time with third party applications as well as HZ's mail services (Figure 9: Data sockets) allowing for accurate personalized up to date information at any time and any place. The aim is to apply this principle wherever possible.

Figure 9: Data sockets

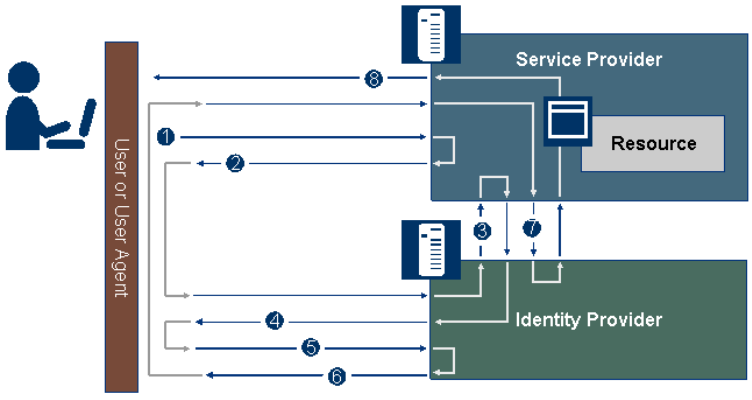
As more and more services are being offered through the cloud students and teachers tend to make more use of them. Current examples are Google-apps, Microsoft 365, etc. and are predominantly offered through SURFconext in which case SURFconext allows for authentication by means of forwarding authentication requests to the federative server of HZ. The authentication process as a whole is based on the use of the SAML 2.0 protocol.

There is however no single sign on (SSO) possible from HZ's current VLE (also web based) to the cloud, which means the user has to leave the site or application when making a connection to an externally offered web service and at that point will be prompted to login again, be it with the same username and password as the session which just has been left. In practice users find this behaviour in the applications odd and disrupting.

In order to prevent this from happening the future Infonet and VLE will allow for users to authenticate through Active Directory Federation Services (ADFS), allowing for seamless integration between their web-based applications, which are offered by HZ as well as SURFconext. This setup also allows for authentication for HZ's own web-services and combined with the developments

A closer look into SAML 2.0 and ADFS 2.0 federation services: SAML 2.0 is an abbreviation for Security Assertion Mark-up Language 2.0 and is a standard for the exchange of authentication and authorisation between different security domains. It is a on XML based protocol and utilizes so called security tokens, which contains assertions in order to exchange information between a SAML-authority, an identity provider, a SAML-consumer and a service provider. The protocol allows for a variety of "cross domain" authentication and authorization scenarios of which the ability to provide "cross-domain Single Sign On" is the most attractive for the HZ.

Although SAML2.0 is widely adopted as a standard, Microsoft does not provide development tools to make web applications suitable for the use with SAML 2.0. It is however possible to have users authenticate federatively for SharePoint, thus allowing for a sort of federative SSO. With regards to the web applications that will be developed by HZ a third party tool (OIOSAML.NET) takes care of SAML authentication.



Process Flow for SSO with SAML 2.0

1. A user attempts to access resource protected by SAML 2.0.
2. The service provider redirects user to an identity provider and includes a SAML artifact referring to the authentication request.

3. The identity provider gets the authentication request from the service provider over a SOAP channel.
4. The identity provider queries the user for authentication credentials.
5. The user or user agent presents the requested credentials.
6. The identity provider returns the user to the service providers with a SAML artifact referring to the authentication response.
7. The service provider gets the authentication response from the identity provider over a SOAP channel.
8. The service provider presents the requested resource to the user.

(Source: http://digitaliser.dk/)

Connectors at a Glance

Before 2009 HZ ICT-policy dictated that all information needed to be provided through one single portal. In 2009 the idea arose to incorporate document management and allow for team sites and flexible reporting (around the same time Microsoft SharePoint became popular in educational institutions because of the promise it held in enabling collaboration and personalization). In 2011 HZ observed how document sharing and distribution had changed through the emergence of services as Dropbox, iCloud, Google docs, etc. and how team sites for example could easily be obtained from cloud provider. The next consideration was, should we not offer students the same functionality as iGoogle, whereby users are allowed to shape and use the portal as they see fit, added with apps and widgets from HZ in order to provide their study information? This would mean a separate, Opensocial ready, student portal is created from which connection to third parties are easily to achieve. As a consequence it would be relatively easy to go a step further and deliver information to other personal devices because of the choice for Opensocial and OAuth by, for example, offering gadgets and apps. What followed was the question whether the VLE should be maintained if information would be provisioned this way. If so, it should offer the same accessibility and usability as cloud services offer.

Opensocial is the industry's leading and most mature standards-based component model for cloud based social apps. Using Opensocial, it is easy to have your app reach users where they get work done; in their activity stream, in content, in email, or even on their mobile device. In addition, OAUTH is an open protocol to allow secure authorization in a simple and standard method from web, mobile and desktop applications. The framework enables a third-party application to obtain limited access to an HTTP service.

Source: http://www.opensocial.org and http://www.oauth.net

The logical consideration that followed was, how do we provide access for teachers to this separate portal environment(s). The greatest challenge with cloud services is bridging the gap between the institutions information provisioning (especially group and course information) and the service in question in cases where the teacher needs to be facilitated with automated maintenance of administration and registration of users and groups who are supposed to use the service. The SURFconext initiative is an example of how this may be solved.

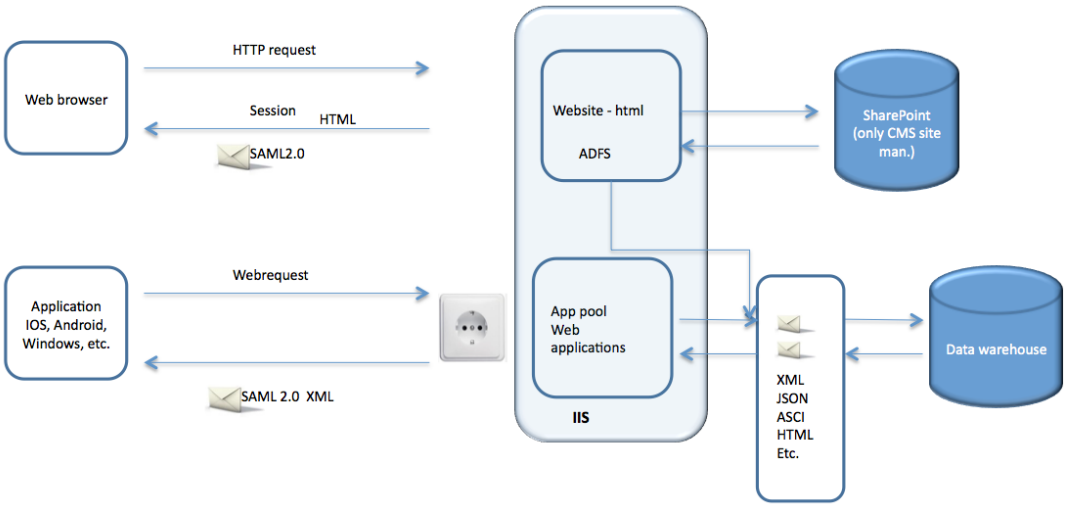


Figure 10: from website to information socket

In any case, the use of connectors or information sockets allows for a far more flexible way for stakeholders to collaborate and communicate than the classical VLE allowed for, while teachers have a wide array of tools available through cloud services for web quests or continues assessment to improve their methods and student results.

Cloud services and cloud strategy

Students and teachers (and staff as well for that matter) are increasingly making use of cloud services in one form or another. If HZ wants to stay in touch with its students it needs to figure out how to incorporate these services into her organization. To try and deny the use of these services or offer substitute services herself is considered to be a fruitless campaign.

There are, of course, strong arguments why cloud services in some situations should not be considered. Privacy and continuity can in certain cases best be kept on premise, it is however an illusion to think that, based on arguments alone, teachers and stakeholders will refrain from the use of cloud services since they will make their own decisions in this area. The only way to respond to this development is to create awareness and offer guidance by pointing out best practices in the use of these services and to lay down clear rules and regulations in which the responsibilities of students and staff are set. In order to be able to set these rules, some (design-) principles have to be defined with, regards to the strategy, as reference points

HZ's cloud strategy distinguishes four application groups in order to decide whether a service is suited for outsourcing or not. First of all, HZ distinguishes applications that are essential for the business processes and over which they need to have control of the data model. An example of this is the course catalogue in which is defined what kind of tests are required and how often these must be administered. This information needs to be automated and linked with the timetabling process and as a consequence does not make the use of cloud services an obvious one. A second category is formed by applications which need guaranteed access to data. These services can be brought into the cloud but demand formal agreements with providers guarantying availability and continuity. The third category concerns applications in which personal context (and thus authentication) plays a role and demands a form of connection with HZ IT-systems (directly or through SURFconext of

Federation). Fourth and last is the category where context of the user is of no importance and users are free to use on their own risk.

A consideration on cloud services: Currently many institutions that have adopted the cloud for (parts of) their IT service provisioning, are in the process of substituting existing services for the same functionality from the cloud. HZ is wondering whether this is a feasible or even desirable development and would like to reassess whether these applications they should be offered at all or just be discontinued. This development is further addressed in the following paragraphs.

5.5 Implementation strategy plan

Concerning its ICT strategy HZ has opted for the use of the “strategic diamond” model (Edwards and Peppard, 1997) for the purpose of decision making with regards to business process redesign. The model aims to classify business processes by clearly defined criteria guided by stakeholder expectations. Underpinning processes are all processes enabling business processes, but which are not recognized by stakeholders and as such do not add value in their opinion. These processes (for example Payroll administration) do not allow for strategic advantage.

Stakeholders recognize qualifying processes but these do not pose a competitive edge and, as such, are not eligible for improvement. The stakeholders also recognize competitive processes and these form a decisive factor for them when making their choice. With regard to HZ this could be accessibility, the way the curriculum is composited, or rostering. Transformation processes concern the organizations ability to keep functioning in an effective manner in the future by enabling anticipation changes. The “strategic diamond” in this model combines the competitive and transformation processes since these are the ones which directly contribute to the institutions overall business strategy.

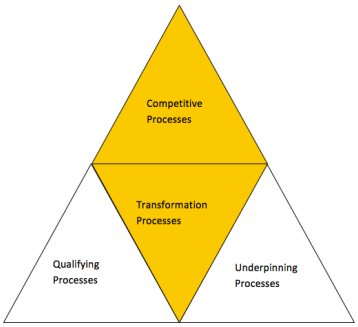


Figure 11: Edwards and Peppard " strategic diamond".

5.5.1 Stakeholder expectations

To be able to test the chosen strategy against external developments it will be compared with the results of research done by the SURF Foundation with regards to future developments in the field of IT within higher education. In the report "acting powerful" the following developments are described per stakeholder group (SURFfoundation, 2006).

- **Students** expect a flexible education and want to offer based on their own experiences and ambition in their own specific tempo. They count on transparent and digitally facilitated education, supported by a digital learning environment allowing for as much as possible

(web-based) self-service. Institutions need to enable continuous learning paths and include a personal portfolio.

- **Teachers** who wish to respond to these needs will need to have an integrated, digital education system, training facilities for education development and easy access to educational and research material.

- **Researchers** assume that the research area of the future will be formed by "collaboratories": virtual research spaces where remote collaboration possible and where everyone has access to the published material. They must have partnering opportunities, transparent sharing of (expensive) research facilities and quality assessments without loss of copyright.

- For the **institutions** IT is a critical instrument, both for the primary processes as well as the supporting business processes. The institution expects a reliable, easy to manage and secure IT environment that is distinct, even in the digital domain and can help reduce the numbers of early school leavers. IT needs to enable cooperation with the region, corporations and industries, offer transparent information infrastructure, IT governance and allow for free access to its own products.

- **Society** needs to benefit from higher education and research, which delivers a strong contribution to a society in which social knowledge valorisation, responsibility and equitable social relationships are central. Society expects valorisation of knowledge benefitting society and an ICT environment in which the protection of personal data and the rights of another is a characteristic feature.

- For **government** alongside with social considerations, economic motives play a significant role. The government will, together with the institutions, invest in a socially responsible ICT environment and aspire to deliver a significant contribution to a knowledge economy by increasing participation in higher education and enforcing governance, transparency and accountability by efficient and effective use of resources and (re)use of developed produce.

The developments outlined in the multiannual SURF inquiry are reflected when compared with both business and IT strategy. The summary of developments gives little cause to adjust the outlined principles and frameworks for the ICT strategy of the HZ.
HZ expects collaborative tools that now are offered through the VLE, and are still considered a competitive element, in the long run will disappear from this category. As a result a shift has been initiated to remove course management and course catalogues from the VLE allowing for flexibility in an eventual outsourcing of collaboration tools to the cloud, using the from the VLE removed tools as stand-alone applications.

5.5.2 SPEARHEADS HZ IT STRATEGY

HZ will make further use of the “strategic diamond” with the business processes and the associated applications in order to assess whether applications should be discontinued, outsourced or kept on premise. In order to outsource applications, strategic alliances are necessary with businesses and other educational institutions. Together with the increasing diversity of new groups of users of HZ’s ICT-infrastructure HZ is aware it needs to revise its policies concerning user identification,

authentication and authorization. HZ aims to shape these policies based on collaboration and federations (such as SURFfederation and SURFconext).

As a result HZ will reduce budgets for the purchase of workstations and develop policies, which will stimulate the use of laptops and the use of privately owned devices. HZ is aware this will lead to an increase in network bandwidth of its (Wireless) network infrastructure and will reserve funds accordingly. The aforementioned division of course management (as a part of educational logistics) and the VLE will be effectuated the coming year(s).

5.6 Differences in IT-strategy between HZ and other institutions

Most institutions struggle with the question how to link the supply and demand of IT to the institutions organisational structure. It is generally acknowledged this is primarily the task of information management (Bruins, 2009) to prevent the lack of adequate imbedding ICT in the organizational structure, leading to the suboptimal deployment of IT in education. Most educational institutions, however, tend to focus on education to develop the potential of IT and have the organization enforce these developments through a formal information manager by the supply side of IT, thinking this will fully unleash the strategic possibilities IT has to offer, thus exploiting its full strategic potential.

For HZ it is clear that information provisioning cannot be seen as a separate discipline whereby the prime responsibility lies at the educational services, but at the heart of the institution and as such needs to be centrally governed.

6 CURRENT ENTERPRISE DESIGN HZ

As discussed earlier in chapter 6, Enterprise architecture covers the whole organization and not just the technical or IT domain. It covers all aspects by means of models, principals and guidelines in order to provide insight into how the domains are interconnected. These aspects are business, functionality, applications and infrastructure (Kruiswijk & Poels, 2012).

When set against "IT induced Reconfiguration" (Venkatraman, 1991), it means the added value of IT increases, as the structure of the organization, its business or products and services changes. As a result of this, IT within an organization cannot be treated as an isolated system, but has to be seen in conjunction with business processes, functionality and technology. Enterprise architecture serves this purpose. Enterprise architecture is defined as a collection of models, principles, guidelines in which the structure, processes, functions, applications and infrastructure as a whole are made clear. These models, principles and guidelines form the fundamental structure of the organization and IT, which is leading, and as it evolves over time.

The four sub-architectures (business architecture, information architecture, application architecture and infrastructure architecture) form the basis for enterprise architecture. Each of these sub architectures consists of a model (visualization), explanation and a collection of principles and guidelines. In the following paragraphs there will be determined what approach is used in relation to the strategic alignment model, will the different architectures worked out in detail and focused on the relationship between information and application architecture.

6.1 ALIGNMENT BETWEEN BUSINESS AND IT

Based on HZ's Business and ICT strategy, it is clear that the business strategy is leading. The information provisioning is arranged accordingly. When set against the strategic alignment model, HZ applies the perspective of technology transformation, which is predominantly reflected in the role the information manager plays within the institution. Set against the Amsterdam information model for information management (AIM) and the interpretation of this model as described in "who is managing the information"(Maes, 2007), HZ's information manager fulfils the role of ICT-partner with regards to strategy, formulating information policies, and as a business partner responsible for alignment. In the following paragraphs each of the mentioned architectures within HZ is explained in more detail.

6.2 BUSINESS ARCHITECTURE / MODEL

Business architecture shows the business processes at a high abstraction level regardless of organizational structure. This is separately mapped together with the managers and the location in the organization where the processes take place. This way, the information provisioning can later be linked to the process architecture in order to show what functionality is required to support the business processes and what applications provide these.

Business architecture provides understanding of structure of the business processes and their mutual dependencies between each other and with their environment (within the chain). This can be supplemented with the products and services of the organization, underlying organizational structure and responsibilities. The model used (Figure 12), is a further adaptation of the variation of Porter's value chain (Figure 1) and describes the business processes as a chain, but allows for a more

in depth analysis of the business architecture by decomposing it in different process levels (Harmon, 2007) thus allowing for a better insight in the processes and their interdependencies as well as clarifying changes and the consequences these changes have on the organization.

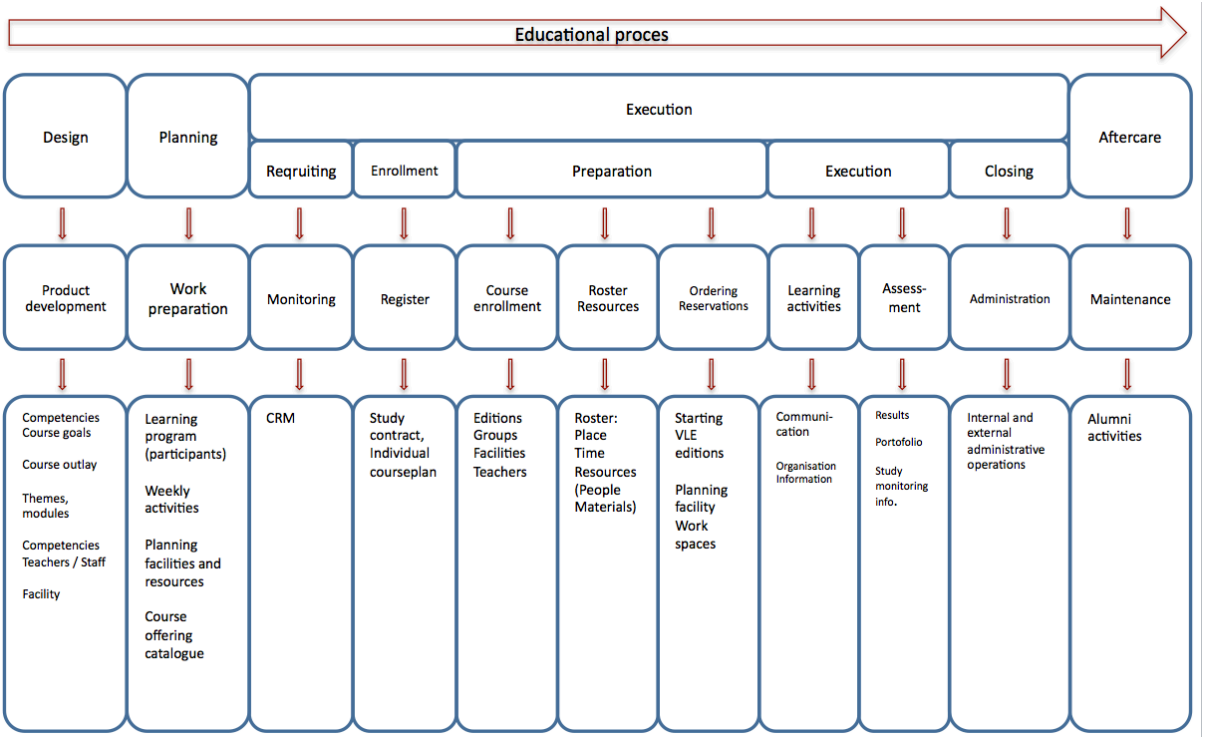


Figure 12: Business architecture HZ

As mentioned earlier, business strategy precedes ICT strategy. The translation into the sub architectures is aligned with the business and environment variables. With respect to the architectural principles, the institutions core values form the guidelines for conducting the business processes as displayed in the model.

6.3 INFORMATION ARCHITECTURE / MODEL

The information architecture focuses on the visualization and description of the functional areas from which the information provisioning is derived (Figure 13). These functional areas are supported by one or more applications. With the information architecture the focus goes out to the interdependence and relationships between functional areas and their relations with the outside world. Attention is also paid to infrastructural facilities such as communication (middleware), presentation (portal) and application transcending data recording (Data warehouse).

The aim of the model is to ensure the function of the information provisioning by mapping main features independent from the supporting applications. Derived from the ICT strategy, the architectural principles that are applied are; the sole use of open standards, adaptation of an organization-wide architecture, the implementation of a central 'counter' for users allowing for single window for all contacts, workflow and business processes form the basis for information provisioning and implementation of performance indicators for processes and document flows.

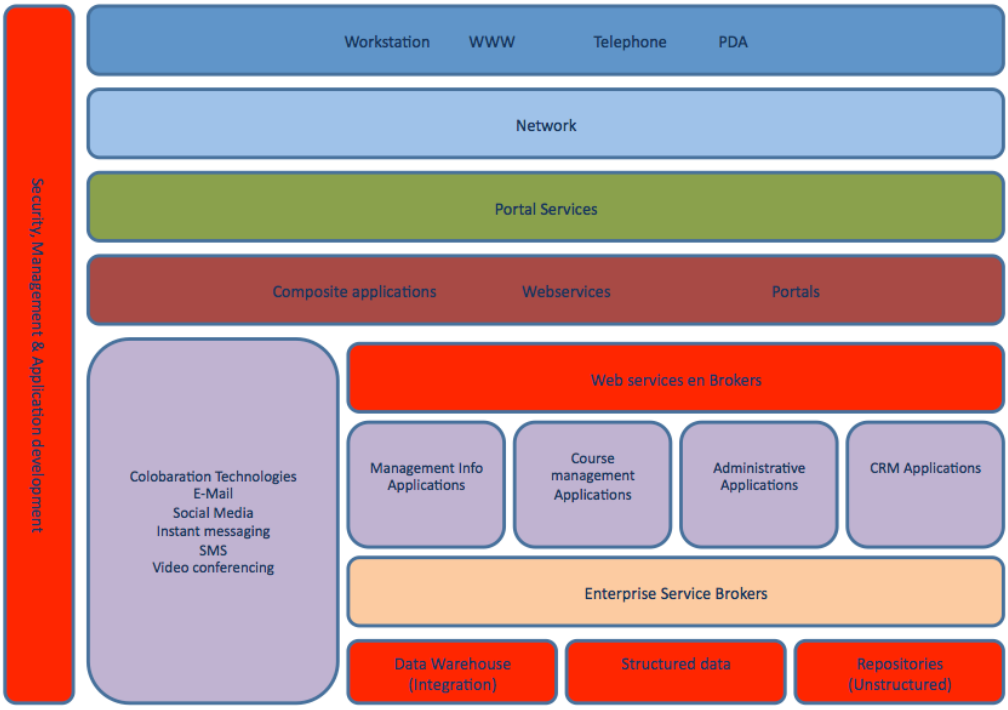


Figure 13: Information architecture HZ

Based these principles, HZ has developed an integrated form of information provisioning that maximizes the possibilities offered by the Internet. Based on the accumulated data in the data warehouse, integrated information to various target groups (students, staff, teachers, management) can be presented web based and through various other channels.

6.4 Application architecture / model

The application architecture provides insight into the existing applications and their interdependent connections. Its aim is not to reflect the functionalities, which are provided, but the coherence and interdependencies between them. The model below (Figure 14) shows the applications with their internal and external relationships. The architectural principles used here are; applications are arranged based on workflow and component based as well as (web-) service oriented, using standardized messaging between applications through the use of enterprise service brokers and subscribers.

A significant number of supporting applications are incorporated in Infonet (an in house developed web portal), which are provisioned by the central database. This data warehouse, in turn, is provisioned through the various couplings with applications supporting the institutions educational logistics. Based on the application architecture, it also becomes clear what choices are made with regard to used operating systems and management tools.

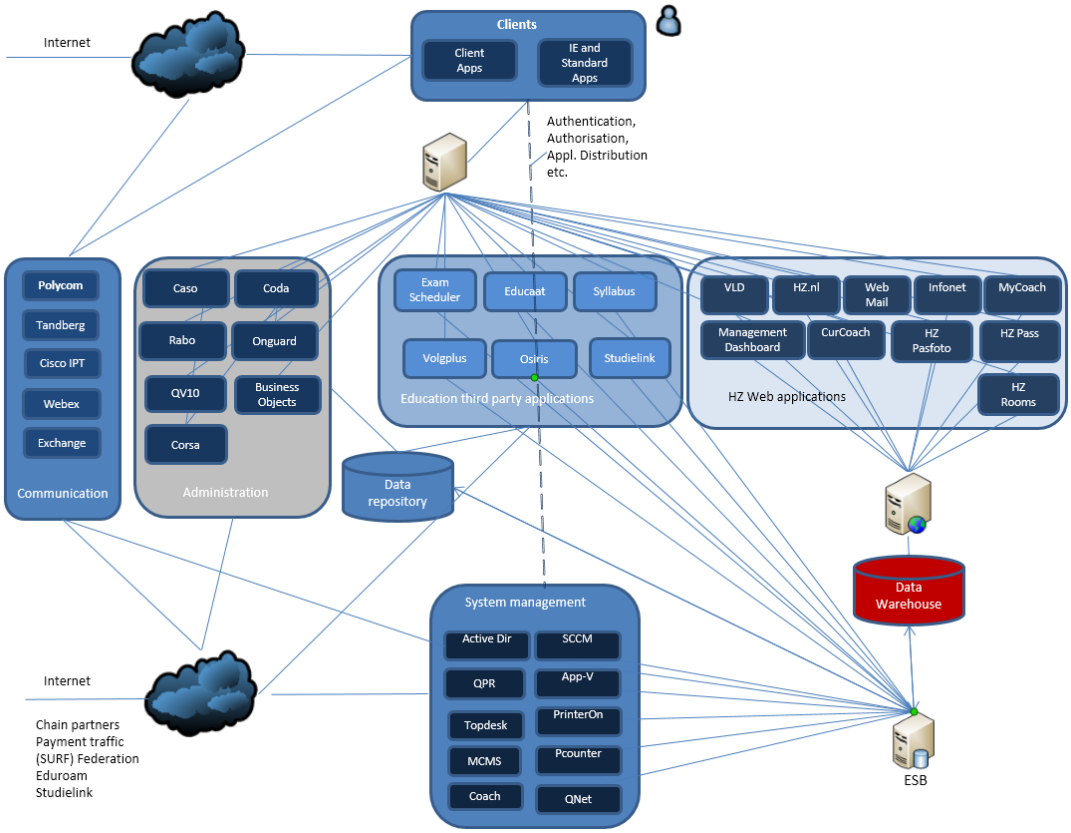


Figure 14: Application architecture HZ

6.5 TECHNICAL ARCHITECTURE / MODEL

The technical infrastructure architecture displays the physical aspects with regards to the institutions ICT infrastructure. When studied closer, there is a resemblance with the medieval analogy from chapter 4. Security and management are applied across the various levels of the IT infrastructure (Figure 15). At HZ there can be four security levels identified in which the Internet represented S4, S3 is accessible to students and staff, S2 only for staff and S1 is accessible only to employees with a particular function or role.

Technical architectural principles are the separation of databases within the technical IT infrastructure, production databases reside with the back office and are aimed at providing information while the use of web services to facilitate the import and export of data. The applied security model is based on user roles and machine roles.

The platform for storage, application distribution, imaging and identity provisioning are Microsoft based. Messaging is handled with Exchange and the majority of the applications running on the HZ are based on Microsoft technology. The custom software is based on Microsoft development tools in order to enable integration with the Data Warehouse. With all the sub-architectures worked out, the next steps are to focus on the relations between them.

Figure 15 represents the server (services) side of the technical infrastructure. The numbers and lines in the figure indicate the priority in which systems are to be restored in case of a calamity and the (technical) interdependencies between the systems.

Figure 15: Technical architecture HZ

6.6 Analysis of enterprise architecture

The focus for this study lies on the relationship between the business and information architecture (What functionalities are needed to support the business processes?) and on the information and application architecture (which applications provide this functionality?).

6.6.1 Information architecture and business architecture

As outlined in the IT strategy, the education process and the organization around it are becoming more and more complex due to the increasing diversity of stakeholders and need for ever greater flexibility. In order to cope with the complexity, a process-oriented approach is needed. Here it is also important that a high degree of efficiency in business processes is realized. This can be a part of the administrative pressure to shift to the students themselves.

The strategy presented in the business goals will entail many uncertainties regarding future developments (Which alliances will be made, what will be the effects be of the introduction of previously acquired competencies certificates (EVC's), etc.). By opting for a process-oriented approach and introducing a 'self-service policy', unbound from time and place, the organization is able to deal more effectively and efficiently with future changes within and outside of the institution.

6.6.2 Information architecture and application architecture

Superimposing the models of these two sub architectures shows the relationship between information architecture and application architecture.

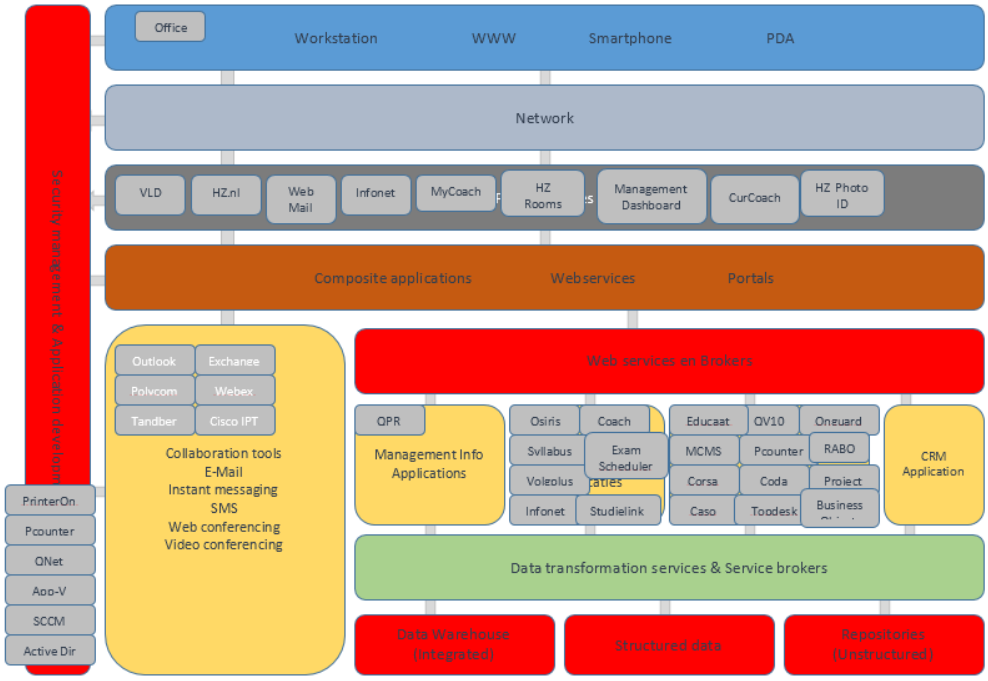


Figure 16: combined information and application architecture

The model (Figure 16) shows that a large number of applications already have been made available through the use of a web portal. It concerns mostly applications supporting business processes, which is in accordance with the IT-strategy. When compared with each other, the sub architectures are complementary to each other. A few applications, such as personnel administration and customer resource management (CRM), have been outsourced to cloud providers, but integrated within HZ's IT-infrastructure.

Information Architecture	Application Architecture
Workflow and business processes as a starting point	Applications arranged based on workflow
Based on open standards	(Web) service oriented Standardized messaging between applications
Portal as a central 'counter' for all users and contacts	(Web) service oriented Standardized messaging between applications
Development of an organization-wide architecture	Applications based on components / modular
Personalized Information Provisioning through the use of "sockets".	Development of API's allowing for connectivity independent of device or operating system.

Table 1: architectural principles

HZ in the future will have to deal with a greater diversity of students and develop new courses that may have to be delivered at different locations and there will be a greater focus on cooperation with external parties, requiring increasing flexibility of the organization.

The IT strategy is aimed at achieving a process-driven organization thus lessening the administrative burden by enabling forms of self-service and self-reliance. This way the organization can respond more quickly to changes inside and outside the organization. Advantages of a process driven

organization are reflected in an increase in the effectiveness and efficiency, the transferability of knowledge, better management of the organization and it reinforces the learning capacity of the organization.
From the Implementation of the information policy, HZ's perspective is one of Technology transformation regarding the provisioning of information. As a result the IT strategy matches well with the requirements for the Enterprise Architecture, concluding that in theory all is well.

6.7 SUMMARIZING HZ'S CURRENT DESIGN, POLICIES AND PLANS

Based on the research, HZ's architectural choices and the offered features, the current DSWE can be described as a classical portal even though it has been developed in house. It functions as a central counter for all information concerning the educational logistic where aggregated data from the data warehouse is presented as personalized information. Through its integrated VLE, study materials and course information are made available as well as information about one's progress. There are basic tools available within the VLE to enable collaboration or exchange of information but these prove to be no longer capable to meet stakeholder's demands.

HZ's first reflex was to provide the desired functions and applications within the confines of the VLE based on the principle guidelines of delivery of content, communication, administration and collaboration. However, during the process of gathering requirements, it soon became clear the stakeholders could not agree over the applications that need to be added nor where responsibilities should lie with regards to provisioning of identities and other administrative tasks and responsibilities. There was however consensus that the current DSWE and VLE are more than adequate with regards to the provisioning of the needed information.

The divide between stakeholders concerning the applications to be used and the way these are to be supported, together with additional demands and requests, has forced HZ to rethink her strategy. How should information provisioning take place against the background of the desired multitude of VLE's in order to meet stakeholder demands? This question resulted in the creation of data sockets that facilitate information provisioning in a personalized way unbound to a centralized delivery point (i.e. central portal). In addition, the discussion also lead to the conviction it will not be for long, when it is no longer possible to provide in all stakeholder wishes within a single portal, thus a variation on the existing "best of breed" policy for VLE's emerged, provisioned by HZ's service brokers. Since the information provisioning is already well organized, it would "simply" be a question of opening it up to the outside world.

7 COMPARISON RESEARCH AND CASE STUDY FINDINGS

An educational institution is in the business of "selling knowledge" to its customers with a focus on research, which resembles a research and development department when an analogy is made with corporate institutions. More than in corporate life, however, clients and staff influence the different strategies within an institution as can be derived from the history of the development of the DSWE.

Through the research it has become clear why and how stakeholder needs have changed under the influence of ever progressing IT developments. The case study has brought forward similar findings, which can be summarized in the following design principles.

- Students are expecting flexible education supported by transparent digital facilities preferably web based and with self-service ability. They tend not to be committed to a single system or application that allows for communication or collaboration, but use an array of (web) applications from a variety of devices best suited for the tasks at hand available at that moment. Applications change fast and often due to rapid development of (web based) applications for a growing variety of devices.

- Teachers need an integrated digital education system best suiting their own needs and applicable for new didactic models, preferably modifiable to their specific needs as didactic insights progress and demands concerning monitoring study progress or curriculum and study materials changes.

- Researchers expect virtual research spaces enabling collaboration, accessible by partner institutions or corporations sharing research facilities in a secured environment.

- For the institutions IT is critical with regards to the primary as well as the secondary processes. They expect reliable and secure IT-environments, which can be easily managed. Their main concerns are enabling cooperation with the region, corporation and industries while maintaining adequate IT governance.

- Finally there is the society's point of view for whom it is important knowledge is constantly valorised for its contribution to society and the knowledge economy in which we live and where government enforces the required governance, transparency and accountability.

Through the case study it is established that, despite well-organized information provisioning and following guiding principles, stakeholders needs are no longer met by the existing VLE. HZ does support the developments as described in the report "acting powerful" and has adopted these for herself in her year-plan. There is however a difference between other educational institutions and how HZ interprets students and teachers wishes concerning the integrated VLE and thus the outcome of SURFfoundation findings.

The premise is that students will not stand for the institution to confine them to using the tools provided through the VLE. In practice they will agree upon the applications they will use for a particular course amongst themselves. The same is the case for teaching staff; the basic tools

provided with regards to the VLE also are not sufficient in order to efficiently deliver the course materials and monitor progress of students effectively.

Whereas standard DSWE's and VLE's are gradually allowing for integration of third party applications, HZ is opting for personalized information provisioning through the use of sockets through the development of API's, thus allowing for connectivity independent of device, operating system or even application. As a consequence of this development the thought arose that the VLE, as part of the DSWE, might be dropped altogether from the DSWE, leaving only the systems supporting the educational logistics enabling information provisioning through the use of API's.

In the following paragraphs an attempt will be made to form enterprise architecture for the new DSWE by combining the findings from the research and the case study and capture these in design rules for the (most probable) future DSWE. Also the differences between the findings of both the research and the case study will be further explored.

7.1 From DSWE to DWE and cloud information provisioning

Based on the activity map in chapter 4, derived from the distributed DWSE as discussed in the research, it becomes clear that information provisioning is seen as a separate discipline, which is the prime responsibility for education thereby supported by utility services. The case study, however, shows that HZ places information provisioning at the heart of the institution, as is the case with the model of Hoogervorst. When translated into an activity map (Figure 17: Activity map desired) the difference becomes clearer. It is against this background the new perspective on the DSWE will be formed. The core activities for the institution can be identified for the development of courses and curricula, the delivery of knowledge to students, improving international orientation and improving cooperation between knowledge institutions. In view of the new perspective, functional and constructional requirements can be identified and defined for the different architectures.

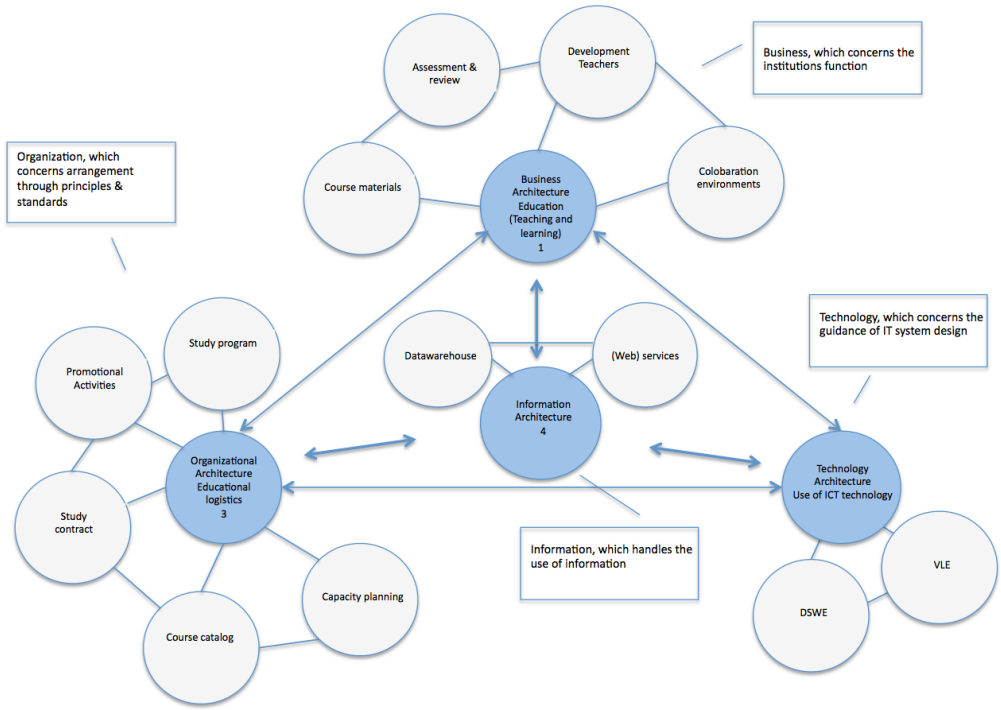


Figure 17: Activity map desired organization

With regards to the business, teachers need to be better facilitated by the DSWE in developing their courses and modules by offering more flexibility and allowing them to use tools of their own choosing. This allows for better possibilities for monitoring study behaviour and study progress and decreases the need for time and place bound education. With regards to the technology architecture, HZ needs to incorporate new technologies to enable better and more flexible cooperation between students and teachers, allowing for the use of the tools of choice. For the information architecture, HZ needs to store student and educational data unambiguously and unify the educational processes in a coherent architecture of processes and information systems as well as support IT in education and research in an institution transcending way

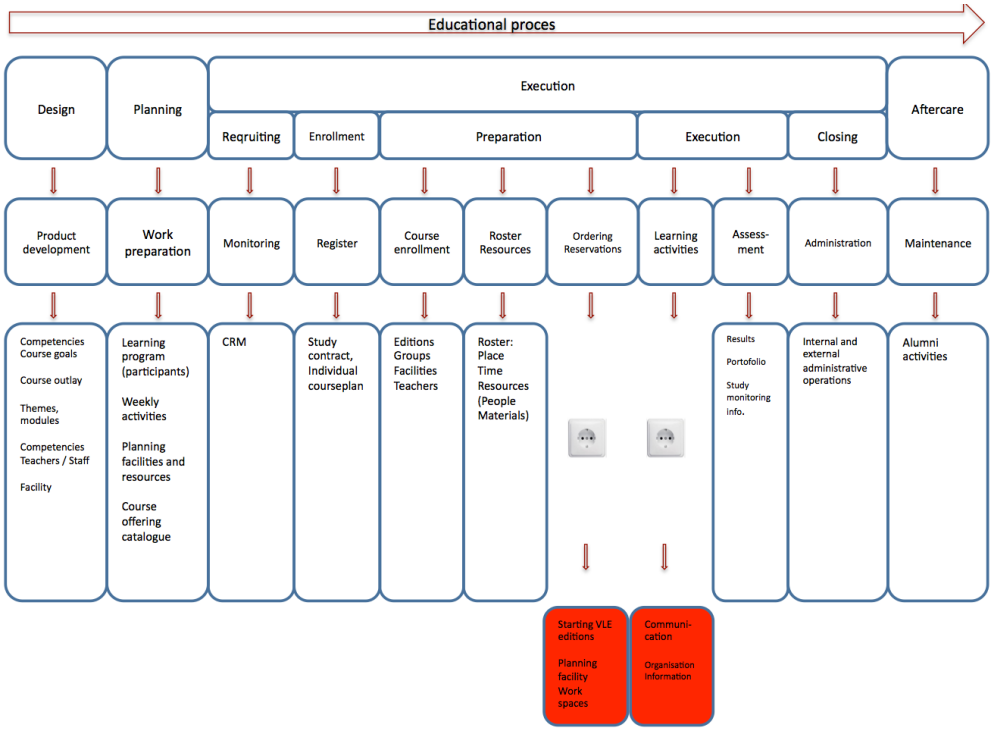


Figure 18: Desired business architecture HZ

From HZ's architectural principals, supplemented with the principles derived from the research, the following design principles can be formulated. Workflow and business processes form the basis for the information architecture. HZ's portal no longer functions as a central counter for all information, but only provisions information concerning the courses, which is also available through other applications through sockets based on open standards. These architecture principles are applicable for the entire institution. When combined with the desired business architecture (Figure 18) the design principals lead to an even more web-based (ICT) environment, with a focus on the possibility for integration with third party cloud services, allowing for the use of the desired applications of choice and support of a broad range of devises whilst staying in control of the provisioning of information.

In the design of the business architecture the arrangement has not changed from the design in the case study as described in Figure 12 on page 43, however, HZ's web services (or service brokers to be more precise) are being made available for the outside world, enabling information provisioning based on the authentication and authorization for a user and thus allowing for transparent information provisioning towards a variety of platforms and systems and greater flexibility while

leaving room for the professionals (teachers) and students to use their preferred tools. In essence one could state HZ is outsourcing its VLE based on the new model of the business architecture. Although not shown in Figure 18, information for other processes and their supporting applications, such as CRM and personnel administration, can be made available in the same way.

The implications of the new business architecture are shown in the new information architecture (Figure 19). When compared with the information architecture from the case study on page 44, Figure 13, the new design focuses on educational logistics on the left side of the model while on the right information is made available and accessible to enable the provisioning of VLE's or other applications.

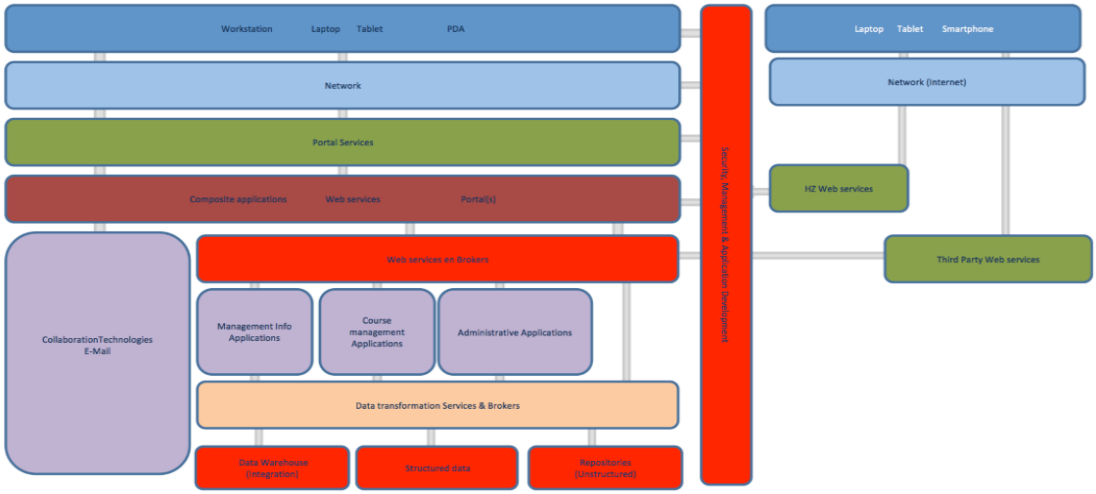


Figure 19: Information architecture

This becomes even clearer after the model for the application architecture has been adapted to the desired situation, providing further insight into the applications and their interdependencies. The architectural principles, which are unchanged, are that applications are based on the workflow and component based (best of breed) as well as web based and use standardized messaging between applications using the Enterprise broker and subscriber scheme.

When compared with the application architecture from the case study (Figure 14 on page 45), the internal centralized VLE has all but disappeared since teachers are allowed to deploy the tools they deem fit, as illustrated by the use of applications as Moodle, Edmodo, etc. and the integration wit other institutions through the use of SURFconext. With regards to the integrated DSWE from the research, there is a difference in approach since there is a tendency to keep in control as far as the institutions ICT environments concerns. From the case study, however, it is suggested this will prove to be impossible. The proposed application architecture does, even though its apparent lack of control, allow for the intensification of education and improved tutoring and, as a consequence may even lead to better social cohesion.

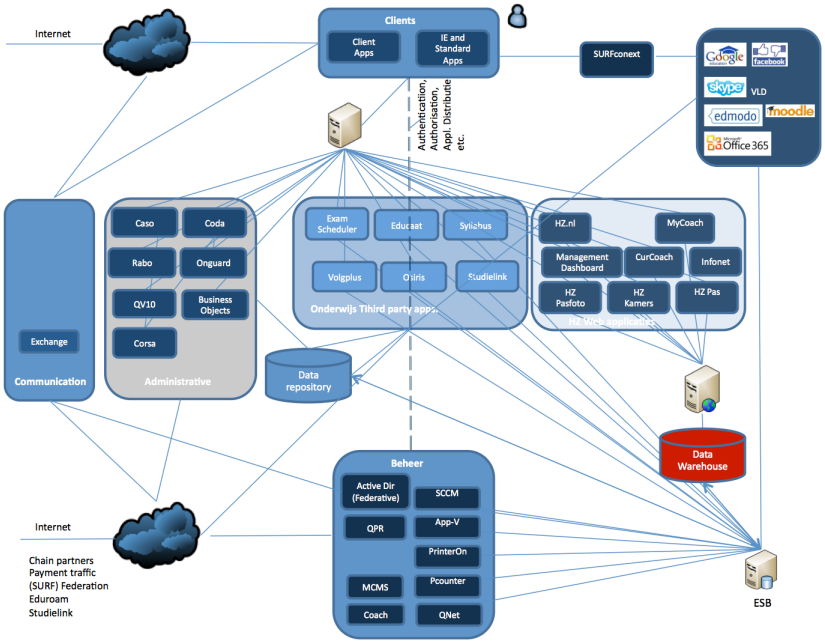


Figure 20: Application architecture

The technical architecture will remain the same as far as the boundaries between the security levels are concerned because of governance policies. Apart from that, the number of workstations and laptops under management of the IT department will be greatly reduced, as (educational) applications will be distributed to users (students and staff) own machines. Since the VLE is all but outsourced to the cloud, the emphasis will shift from implementation and (troublesome) integration of applications within an existing system, to information provisioning to cloud-applications through open standards, greatly reducing the complexity of the on premise technical ICT-infrastructure.

When at last the information and application architecture are merged together the relationship between the two provides insight in the changes that are suggested and the effects they have on the application landscape. When taking a closer look at Figure 21 it becomes clear that the chosen approach of ending the support of an on premise VLE (i.e. the support of standardized mandatory collaboration and communication tools) leads to a lean and agile organization of the business processes.

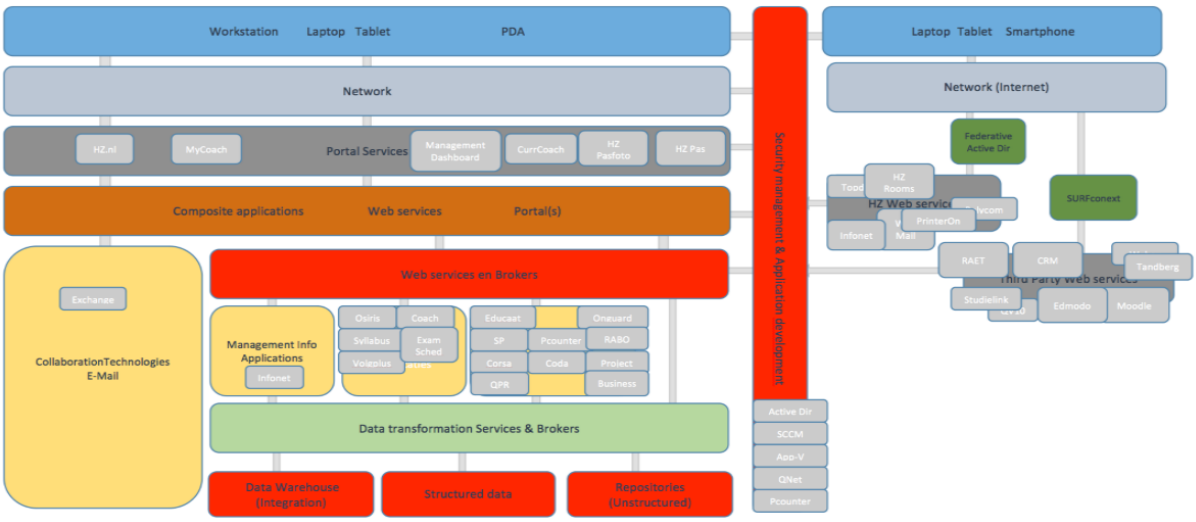


Figure 21: Combined information and application architecture

When set against the research and the activity model of the extended DSWE, the organization of education has been deemed a separate core activity from which the responsible organizational unit is trying to keep up with current educational and technical developments. Because of the focus on education within this part of the organization, institutions organized in this way, seem to try and keep up by adapting their application and technical architecture, allowing for the integration of manifestations of these developments within their existing ICT-environment. The pace, however, of these technical developments, as well as the speed in which insights, rules and regulations are altered, demand a different approach. This is an indication that information management should be considered a core competence for educational institutions and as such it should not predominantly focus on education, as is the case now based on the research study, but the business as a whole, providing a holistic view of the organizations processes. HZ's SOA based approach, together with the somewhat daring idea to get rid of the centrally hosted and administered VLE, could well serve as an example.

In their ICT-strategy plans HZ chooses to adopt a "best of breed" policy in order to maintain the greatest possible flexibility and reach the desired integration of information through the creation of a data warehouse in a service oriented approach through service brokers and subscribers. This way the process-oriented organization of education can be maintained while staying "future proof". These choices have been established in HZ's information and application architecture principles.

In order to give an impression of the SOA-approach combined with sockets an example is given to illustrate the chosen strategy whereby the VLE best suited for the courses can be deployed by teachers, much in the same way HZ maintains her best of breed policy for the applications supporting the educational logistics.

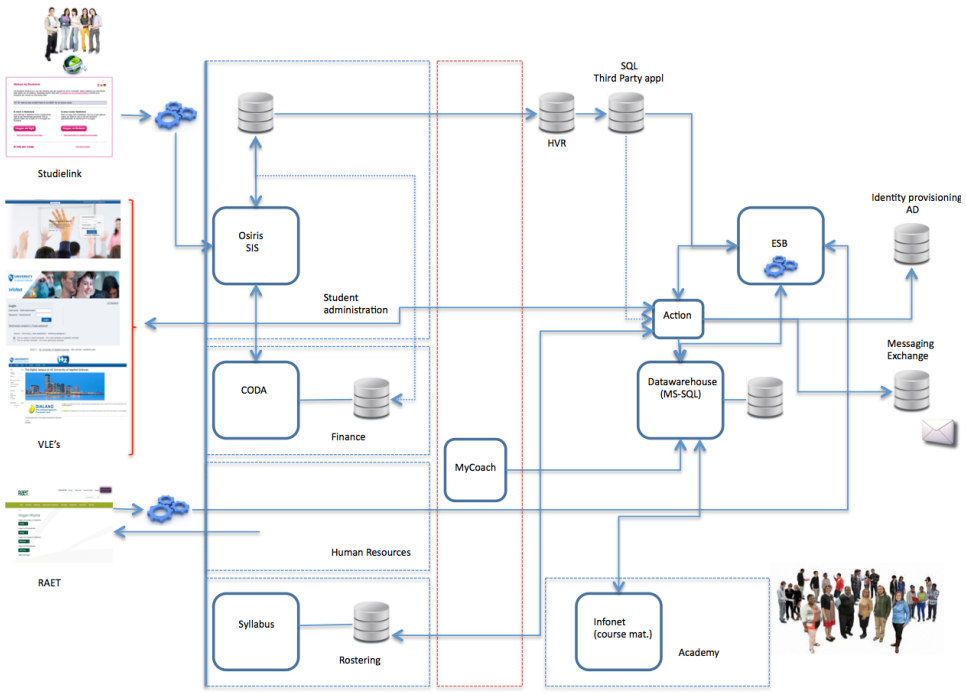


Figure 22: Business process broker overview

Since authentication and authorization services are made available outside the HZ through federative authentication services (see explanation SURFconext on page 18) and assuming the VLE of choice supports this way of registering, HZ's users and groups can be easily integrated within the site

management of the VLE, allowing for easy administration of users and course materials. Since the enterprise service brokers translate the business processes into actions and react to changes in the data that is provided from the source systems, it should even be possible to automate the provisioning of the new learning environments from HZ's data warehouse through its brokers that are standardized.

By redesigning (or "opening up") the information provisioning through the use of sockets based on open standards, the institutions ICT environment takes a step in the right direction in HZ's desire to create a flexible future-proof process-oriented organization. The suggested strategy as in the presented ICT-strategy and the way this is aligned with business plans and objectives do, however, hold certain risks that call for clear IT governance.

7.2 SHIFT IN GOVERNANCE

There are several definitions of IT governance. The leading IT Governance Institute (ITGI, 2013) defines IT Governance as follows: *"The responsibility of executives and the board of directors consists of the leadership, organizational structures and processes that ensure that the enterprise's IT sustains and extends the enterprise's strategies and objectives."* and as such covers the full design and arrangement of the business (IT) processes. MIT Center for Information Systems (CISR, 2012) defines IT governance as follows: *"…a framework for decision rights and accountability to encourage desirable behavior in the use of IT".* This definition distinguishes governance from IT management. IT management is the daily decision-making and implementation activities around the firm's use of IT. Governance identifies who will make key IT decisions and how they will be held accountable and enables and reduces bureaucracy and dysfunctional politics by formalizing organizational learning, thus avoiding making the same mistakes over and over again. CISR's definition is along the line of Hoogervorst's definition. To repeat the definition Hoogervorst provides for IT governance: "*The organizations competence needed for the continuous execution of guiding authority over IT-strategy and architecture development and the design and implementation of IT-systems in the institution".*

Because of Hoogervorst's reference to the organizations competences (i.e. all stakeholders), the mention of guiding authority and the overall holistic approach, it better suits the new situation by delegating responsibilities to users instead of placing all responsibility with the institutions board. When the latter is not willing to delegate responsibilities and shift accountability towards the stakeholders, there will be little future for Web 2.0 applications within future VLE's since the principle of these applications, either within or outside of the DSWE, are based on the premise of users sharing files and collaborate in creating content. The delegation of responsibility and accountability through governance, however, does not address the risks resulting from the opening up of the DSWE, or more specifically, the delegation of the VLE.

7.3 SECURITY IN HIGHER EDUCATION

The national platform for data security experts in higher education (SURFibo, 2010), together with the Chief Information Officers council has drafted a collective policy paper concerning information security, which can be defined as a set of measures aimed at ensuring quality aspects such as availability, integrity and confidentiality of the information provisioning. As such security is an inextricable part of IT Governance

7.3.1 Rules and legislation

With regards to these aspects availability concerns the degree to which information or features are available for users in a timely fashion and integrity concerns the extent to which information or functions are properly represented as whereas confidentiality is about access to information or functionality, which is to be restricted to only those who are authorized. An important role is also set aside for the auditability of measures that have been taken in assuring these aspects of quality.
The proposed architecture must meet relevant legislation and regulations. Specific for higher education there is the law on higher education and scientific research, which requires institutions to implement a quality assurance system in which the careful handling of data in the student administration and study results is guaranteed. In addition, integrity codes for scientific research are observed and applied. Other applicable rules and regulations are the data protection act in which an institution is legally required to take appropriate measures against loss and unlawful processing of personal information, which is stored in (automated) systems. These measures must be documented and implemented through an information security policy to which the entire institution has to comply.

Legislation concerning archiving contains regulations on how to handle information recorded in (digital) documents, information systems, etc. and is a primary source for information in the annual external accountants reports. Other relevant laws are the copyright law that prohibits institutions to distribute original work without permission of the owner of the copyright, as well as the use of software without owning the proper licenses and the legislation concerning telecommunications that applies when institutions offer publically accessible network services, in which case the institution has to protect the privacy of the users in these networks. The last one, which is important to mention, is the computer crime act that focuses on criminal actions in relation with the use of automated systems and, as a result of, requires institutions to provide in some form of protection or security.

Besides rules and legislation there are additional directives and agreements to which an institution is bound such as the integrity code for scientific research, formal agreements with Studielink and the terms and conditions SURFfederation and SURFnet imposes on the use of their services.

7.3.2 Guidelines and code of conduct

Because of the institutions obligation to comply with the given rules and regulations (IT) governance dictates policies containing guidelines and a code of conduct concerning information security. These can be intended for specific stakeholders or generally applicable. Examples are, for instance, Acceptable use policy guiding the safe use of ICT-facilities, Password policies and the application of cryptographic aids and (data) classification guidelines. With regards to user conduct integrity and a code of conduct can be imposed.

7.3.3 Consequences for stakeholders

With regards to Security, policies and measures alone are not sufficient to rule out all risks since people are the key players. Only through constantly raising awareness with the end users and encouraging responsible behaviour can risks be reduced. It has to be made clear that the information security policies are applicable to all users authorized for using the DSWE and cover all forms of information provisioning, be it on behalf of the institution or on a personal note, on which the institution may be held accountable.

Staff and students in future will be expected to behave in a decent manner and act responsible regarding the use of technology guided by the core values of the institution in order to prevent situations, which may lead to reputation damage or unsafe situations. This cannot be achieved through technical measures alone, but requires stakeholders to commit to the given guidelines and code of conduct regarding the use of technology by accepting responsibility for their actions. This can be achieved, for example, by having them sign a written agreement before issuing login account information or by using an opt-in option before granting access to the requested data.

Through the way by which the desired architecture is composed and by regarding the institution as a social-technical system wherein governance rests on the creative and intellectual capacities of stakeholders, the complexity and dynamics of the institutions and its IT-systems are addresses in a unified and integrated manner ensuring contextual legitimacy.

Summing up the proposed architecture, guiding principles and stance with regard to stakeholders conduct, the future of the DSWE is one of centralization of the supporting business processes organizing educational logistics and enabling connectivity allowing for creativity, productivity but also more personal responsibility.

8 GENERAL FINDINGS AND CONCLUSIONS

The initial question at the basis of this research was: *How can emergent technologies and changing stakeholder needs, successfully be incorporated in higher education institutions?*
After research followed by an elaboration of the current Enterprise Architecture from the case study of HZ's DSWE, a new design was created which incorporates new and additional design principles. Together with the preliminary answers from chapter five, this chapter will be used to formulate the final answers to the sub-questions in order to find a new perspective on the issues as described in the initial problem statement.

The first question was: *Is there such a thing as a standard DSWE and if so, how is it designed and what are its guiding principles?*
Results from the literature studies combined with the findings of the case study show there is a clear definition describing the Digital Study and Working Environment and indicate there are broadly defined guiding principles for a DSWE; delivery of content, communication, administration and collaboration.

The second question was: *Who are the stakeholders and what are their interests?*
The stakeholders have been identified through the research (roughly) and case study (in detail). With regards to the subject matter, the stakeholders who are the instigators for change within the DSWE are the students as well as teachers who, in their role as prosumers, aim to claim control in shaping their own Virtual Learning Environments.

The third sub-question was*: What factors are driving changes in Educational institutions and IT regarding the DSWE?*
This question is partly answered in the previous question indicating changing needs and demands of the stakeholders. This is a consequence of current strategic demands for tools that better enable monitoring and analysis of study behaviour and improved facilities enabling students to collaborate thus enabling more involvement and commitment, ultimately, reducing the number of dropouts. It is

of vital importance for institutions, especially for teachers, to fully embrace the possibilities IT-technology has to offer in being able to reach these goals.

The fourth sub-question was: *What are current emerging technologies and what is their influence?*
The most important technologies are the developments in Web 2.0 and the resulting applications that it enables. Although strictly speaking no technologies, consumerization and byod have also led to drastic changes in IT-management since they allow for students, teachers and staff to become more self-reliant in meeting their personal IT-needs, especially combined with the current abundance of cloud based software services. It is through these developments, the direction of IT services can no longer be considered solely the domain of the institution.

The fifth sub-question was: *What will the future developments for the DSWE be?*
Based on the research and design of the new DSWE and the possibilities it offers users, because of the underlying principle in which personalized data can be accessed from the Digital Working Environment through the use of sockets, it is to be expected the DSWE will transform into a digital working environment enabling a variety of third party web services (in the form of educational learning portals or other manifestations). In effect, the number of on premise applications will decrease and focus on the educational logistics, providing information to a multitude of externally hosted applications. When set against Edwards and Peppards "strategic Diamond", the chosen approach can be placed under the transformation processes and, in fact, will greatly enhance the possibility for an institution to effectively anticipate to changes that directly contribute to the overall business strategy.

8.1 Reflection and recommendations for further research

Based on the results of this research paper it seems clear that IT-developments in education are moving towards more personalized and dispersed environments. Illustrative to this development is the sheer unstoppable emergence of personal devices aimed at the individual user, linking individuals' preferences and (mostly cloud-) applications all within a single system.

Looking at internet and the impact it has on connectivity and thus on the way we communicate, there seems to be a trend on fragmenting applications, each of them providing a personalized way to interact with whomever or whatever data. Other than is the case for corporate IT-management, there seems to be a decline in "loyalty" to applications from a consumerization point of view. As soon as a group early adaptors picks up on a new development, followers seem eager to adapt their choices. Since connectivity costs next to nothing and apps are being developed en mass against relatively low costs, users will be switching more easily to new applications that are giving a better user experience.

> *The fickle, fashion-conscious nature of technology consumers means that they are always shifting to the next "big thing."*
>
> S. Taylor, Cisco Internet Solutions Business Group.

As such, current developments may indicate a movement away from integrated enterprise applications, which embodies all of the business process logic within one application whereas, based on the literature study and case study, integrated services result in time savings.

The proposed DSWE focuses on the data and the way this can be distributed rather than creating rigid enterprise wide integrated applications. Based on the findings of this study, the expectation is that focus will shift to the data and subsequently the way the information is distributed. Only this way can the desired differentiation, brought on by continuous technological developments, be achieved in a timely fashion.

Rather than speaking of an extended integrated DSWE as mentioned in the research, the DSWE's may very well be shrinking. It would be more accurate to state institutions are integrating into the cloud by disposing of services in which it cannot distinguish itself from other institutions or vendors. At any rate, an attempt to incorporate new technologies into an existing DSWE will prove to be an expensive endeavor since institutions will prove to be unable to keep up. The only way in which this can be avoided, is to develop an architecture that allows for flexibility and which is preferably independent of manufacturers or developers. Only by avoiding a "one size fits all" policy, can the desired differentiation be achieved. The telltale here should be the demand from stakeholders for personalized information, accessible through applications and on devices of their own choice.

Based on the results of this study it will be interesting to further research the implications of the findings with regards to governance since consumerization will inevitably place some of the burdens of IT-management from institutions into the hands of the stakeholders.

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