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Digital Transformation in Higher Education – The Role of Enterprise Architectures and Portals

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Abstract: Digital transformation is considered as one of the mega-trends in industry and the public sector. One of the sectors with potential for digital transformation is higher education in universities and university colleges. Many universities and schools developed digitization strategies and new kinds of offerings for their traditional target groups and for new, non-traditional target groups. However, digitization and digital strategies often are limited to digitizing the content of lectures and to opening access to education modules by offering them online. We argue that digitization strategies should include a wider focus and propose that enterprise architecture management could provide an important contribution in structuring digitization efforts and that enterprise or knowledge portals could play a role for implementing the strategies.

Keywords: Digital transformation, higher education, enterprise architecture, portal.

1 Introduction

Digital transformation is considered as one of the mega-trends in industry and the public sector. In general, digital transformation describes the shift from traditional (often physical) creation and delivery of customer value, including the operational procedures related to this, into the massive use of digital technologies which enhance or replace the traditional product or services with digitized ones. According to a white paper of the World Economic Forum [WEF16] digital transformation offers a huge potential of innovation in the magnitude of several trillion US$ and addresses industries (e.g. logistics, healthcare, automotive) and public sector applications (e.g. healthcare, government). One of the sectors with potential for digital transformation is higher education in university and university colleges. Many universities and schools developed digitization strategies and new kinds of offerings for their traditional target groups and for new, non-traditional target groups. However, digitization and digital strategies often are limited to digitizing the content of lectures and to opening access to education modules by offering them online. We argue that digitization strategies should include a wider focus and propose that enterprise architecture management could provide an important contribution in structuring digitization efforts and that enterprise or knowledge portals could play a role for implementing the strategies concerning educational services.

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The paper follows an explorative research approach by combining theories and findings from various sectors of research and applying them in higher education. Most of the work presented is based on an argumentative-deductive research approach. A case study from Rostock University serves as basis for illustrating the proposals and validating ideas.

The remainder of the paper is structured as follows: Section 2 presents the background for the research work from enterprise architecture management and portals. Section 3 discusses digital transformation in higher education and presents possible transformation strategies. Section 4 shows examples for using these strategies from a real world example using enter prise architectures as guiding means. Section 5 discusses the use of enterprise portals for strategy implementation. Section 6 summarizes findings and discusses future work.

2 Background

This section summarizes relevant background for our work from enterprise architecture management (section 2.1) and enterprise and knowledge portals (section 2.2).

2.1 Enterprise Architecture Management

In general, an EA captures and structures all relevant components for describing an enterprise, including the processes used for development of the EA as such [Ah12]. Research activities in EAM are manifold. The literature analysis included in [WK15] shows that elements of EAM [Bu10], process and principles [Jo04], and implementation drivers and strategies [Sa15] are among the frequently researched subjects. Furthermore there is work on architecture analysis [Jo07], decision making based on architectures [Jo04 and IT governance [Si10]. However, there is no specific focus on the integration of product-IT and EAM.

Of specific relevance for digital transformation are EAM frameworks identifying structures and dependencies in EA. In this context, TOGAF [TOG11] is considered by many researchers as industry standard and defines three different architectural levels which are visible in many other frameworks: The Business Architecture defines the business strategy, governance, organization and key business processes. The Information Architecture is divided into two sub-layers: Data Architecture and Application Architecture. The Data Architecture describes the structure of an organization's logical and physical data assets and data management resources. Its objective is to define the major types of data, necessary to support the business. Data Architecture is also called Information Architecture. The Application Architecture provides a blueprint for the individual application systems to be deployed, for their interactions and their relationships to the core business processes of an organization. The Technology Architecture describes the physical realization of an architectural solution. The logical

software and hardware capabilities, which are required to support the deployment of business, data, and application services, are also defined in this dimension [TOG11]. ArchiMate [TOG12] is a notation for modelling TOGAF.

2.2 Portals

A *portal* allows access to consistently integrate heterogeneous applications or data sources [DG02] and generally describes a Web application in which contents, services and functions are integrated [CC02]. *Enterprise portals* provide the user with personalized internal and external corporate information as the basis for business decisions [ST98]. In addition to the employees of the enterprise the customers and business partners are increasingly explicitly included in the portal. *Community Portals* address the need to structure and further develop contents that are available on the Internet for specific areas of interest. These interest communities are not based on any formal membership and are largely self-organizing. Examples are *Community Web Portals* [Sta00] and portals for *Communities of Practice* [Tur99].

A further group of portal terms results from using the portal contents and their structuring. *Information portals* provide the access to high quality information for particular target groups [Ag03]. The term *Semantic Portal* is usually used when formalized conceptual models, such as ontologies and related technologies of the Semantic Web are applied to support, for example, restructuring, presentation and navigation in portal contents. *Organisational Memory Systems* are IT systems that implement the knowledge base of an organisation while simultaneously supporting the use of the knowledge base [Leh98]. Knowledge portals [Sa05] are therefore to be regarded as Organisational Memory Systems provided individualization and process support are focused on organizational matters.

3 Digital Transformation in Higher Education

Our approach to analyse possible digital transformation paths in higher education is based on a general digital transformation model which is presented in section 3.1. Section 3.2 applies this general model and elaborates selected general digital transformation paths in higher education. Section 3.3 investigates which enterprise architecture layers are affected by the different approaches in order to identify tasks to be tackled in enterprise architecture management.

3.1 Digital Transformation

In many industrial domains, products and services traditionally are delivered based on physical infrastructures (e.g. shops, bank offices, service centres) or persons (e.g. sales agent, broker). Often, also the products are physical ones and the operational processes

are using physical support. Customers in many of these domains increasingly expect that apps, mobile services or services accompanying the products offer additional value for them, i.e. the providers of products or services have to decide how to improve the overall customer experience or their products. In this context, digital transformation describes the shift from traditional (often physical) creation and delivery of customer value, including the operational procedures related to this, into the use of digital technologies with the aim to enhance or replace the traditional product or services with digitized ones. In order to further investigate the digital transformation, we used a structural approach for analyzing digitization paths proposed in [BB11]. This approach considers two dimensions of potential digitization, the digitization of the product offered by a company and the digitization of the operational procedures for offering these products. In both dimensions, three steps are distinguished (see figure 1 a).

In the product dimension, these steps are to *enhance* (add complementary services to a product), *extend* (new product features by using digital components) or *redefine* products (newly designed products replacing the earlier generations). In the procedure dimension, the steps are *create* (new and IT-based operating capabilities), *leverage* (the new capabilities for more efficient procedures) and *integrate* (more efficient and traditional procedures).

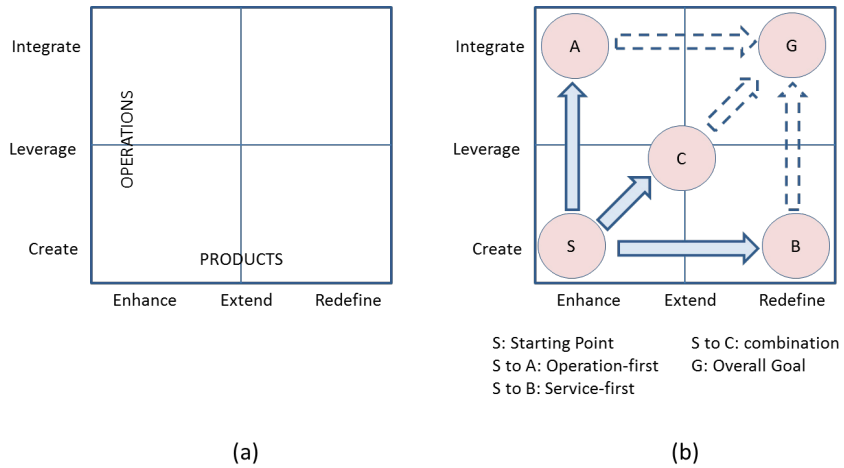

Fig. 1: Dimensions of the Digital Transformation approach [BB11]

3.2 Digital Transformation Paths in Higher Education

Assuming that the overall objective of digital transformation in higher education is to achieve a redefinition of education services and accompanying re-development of operational processes, there are at least three different possible paths which have to be considered:

- Service-first transformation focusing on a change and redefinition of services before addressing major improvements and changes in operations.
- Operation-first transformation aiming at new and improved digital internal processes as a basis for later redefinition of services.
- Service – operation combination attempting an integrated transformation of both aspects.

Operation-first would basically require a digitization of all value creation and most supporting services. Value creation in higher education is everything related to the education process of students from admission, registration for programs and courses, examination in courses, the development of programs and their quality assurance, etc. Supporting services include facility management, study planning, scheduling, teacher allocation and much more. All in all this basically requires an integrated campus management functionality including support for mobile workers and for knowledge management.

Service-first would have to focus on creating new education products and transforming existing products into digital ones. One aspect of this activity is opening established education programmes for access from outside the higher education institution on national and international level. This is usually connected to making the content of the education digital and to also providing digital means for student – teacher and student – student interaction and collaboration. Internationalization also requires adaptations regarding the applied language. Furthermore, most traditional education programmes need to be decomposed into a smaller level of granularity, e.g. instead of three year study programmes into shorter certificate courses and instead of 6 ECTS teaching modules into smaller but combinable modules. Such decomposition would support to offer them for a wider target group and increase flexibility.

Service and operation combination would be a systematic inter-relation of both approaches presented before. This could, for example, be a new study format for a new target group of the university in combination with digitization of the operational processes related to the new study format and target group. Many of such combination paths result from pilot project for implementing digitization of higher education.

4 Enterprise Architecture and Portals supporting Digital Transformation in Higher Education

This section focuses on a discussion about the role of enterprise architectures and portals in implementing digital transformation. For this purpose, section 4.1 uses an excerpt from the enterprise architecture of Rostock University, which serves as an illustrative case for this paper, and section 4.2 presents experiences regarding required changes in this enterprise architecture and the role of portals.

4.1 Enterprise Architecture – An example from Rostock University

The concept of enterprise architectures in general and the TOGAF as a standard in the field were briefly introduced in section 2.1. In this section, we structure our discussion about the effects of different digital transformation paths (as presented in section 3) on the organization by considering the different enterprise architecture layers according to TOGAF. As a means to illustrate our view, we use an excerpt of the enterprise architecture of Rostock University. This excerpt originates from earlier work in published in a capability management project [Pi13], campus management and an e-learning project [Sa15].

The current situation of the enterprise architecture at Rostock University can be summarized as follows:

- Business architecture: established catalogue of administrative services for internal research and teaching, human resource management, facility and other supporting services. Coverage of all student lifecycle phases in business processes (from application to issuing exit certificates). Bachelor, Master, and PhD program development and delivery at the facilities of Rostock University.
- Application architecture: various information systems providing support for certain functionalities in administrative and supporting services. Partly integrated systems for managing student lifecycle and for planning and operating study programmes. Learning management and training software modules. Multitude of specialized application for specific faculties of the university. Various literature databases and library systems.
- Data architecture: no enterprise-wide data model but functionally integrated data models and exchange possibilities (e.g. for student lifecycle management, for administrative purposes, for facility planning, etc.). Teaching content captured digitally but often not integrated with administrative data.
- Technology architecture: central IT-infrastructure for the university with additional decentral environments for some faculties and research units.

4.2 Digital Transformation Paths in Higher Education

In the service-first strategy the most severe changes have to be performed in the application architecture as new platforms for delivery of innovative education products or services have to be implemented. This could, for example, be MOOC platforms or support for collaborative learning and peer learning in distributed student groups who cannot attend on-campus teaching modules but are geographically distributed. The business architecture also will be affected of service-first transformation paths as online examination procedures and modified workflows for issuing certificates or arranging on-site modules might be needed. However, most of the traditional campus management functionality should stay stable. In the data architecture, one of the important changes is the more intense use of digital content and the integration of different media types with administrative course and student data.

In the process-first transformation path, digitization of all value creation and supporting processes is in focus, which from an enterprise architecture perspective affects the business architecture most and – for alignment of business and IT – also the application architecture. In the business architecture, the implementation of digital processes and their optimization usually is only one aspect to be tackled. Equally important is the adaptation or organisational structures to changed processes and the creation of new organisational functions, e.g. an organisation unit for online education programmes or certificates. In the data layer, a better integration of data models of the information systems supporting operative processes is required.

For the combined service / process transformation paths, the above changes and adaptations in service-first and process-first transformation paths also have to be performed but this usually is performed with focus on single departments or a clearly defined organizational scope. An example would be to start with digital transformation in all education programmes outside the traditional Bachelor/Master system and continue with internationally oriented programmes. It can be noted that in all three transformation paths all architecture layers are affected.

5 Portals as a Support for Strategy Implementation

The focus of Rostock University's digital transformation strategy currently is on the education programmes and services offered, i.e. the strategy can be as "service-first". In 2015, the university decided to create online courses based on MOOCs and new certificate programmes for non-traditional target groups. The project KOSMOS supports the implementation of these new services. KOSMOS aims at attracting new target groups to university education and to develop and explore new study formats. New target groups are, for example, experienced job professionals who completed their higher education long ago, or practitioners without a sufficient level of formal qualification but much experience from practice. New study formats are, for example, short study programmes (6 months or one year) for mixed target groups and a combination of on-

campus and online teaching.

In KOSMOS it became clear that a portal for teaching and learning could serve as an integration point to implement the strategy. New target groups and formats need an adjusted or different kind of support by learning management systems compared to the traditional target groups, since didactic and pedagogical concepts also differ. In order to facilitate this adaptivity requirement, the approach is that learning management systems (LMS) should be flexibly adaptable to the learner's individual demands when it comes to contents and applications supporting the learning process. In KOSMOS, this LMS is a portal integrating existing and future learning objects and tools supporting the different learning phases. This portal is called "MyKosmos".

The MyKosmos portal integrates different functionalities and applications into a single user interface. Examples are:

- Meta-search engine: one element of the integration is to provide a single user interface to searching several literature database and research information systems. Based on the student profile (i.e. the study format, current integration into working groups and personal background), the meta.search is configured to search with priority in those database assumed to be the most important ones for the task at hand.

- Integration of learning management systems: Rostock University has a learning management system for supporting teaching in different courses (Stud.IP[3]), for interactive content and learning objects (ILIAS[4]) and for scheduling education and providing individual information (LSF[5]). These systems are integrated into the MyKosmos portal provided a joint view on relevant data.

- Collaborative work of distributed student groups is supported by integrating synchronous (Skype[6]) and asynchronous communication, document sharing, joint editing of documents and awareness functions for group work.

- Program managers and course responsible persons (teachers) may integrate additional functionality into the portal by using the "portlet" concept of the Liferay platform which forms the basis for MyKosmos.

The above summary shows that MyKosmos is contributing to the integration of various applications which in turn is part of the digital transformation activity. Furthermore, the portal also contributed to ´development of more synchronized work flows as the portal development was prepared by business process integration activities. More concrete, we modelled all future usage scenarios for the portal and derived integration needs on process and application level from the scenario models. For this purpose we used an

[3] http://www.studip.de/
[4] http://www.ilias.de
[5] https://www.his.de/produkte/sva-fsv-gx-campus/lehre-studium-forschung.html
[6] https://www.skype.com

approach from enterprise modelling based on Troux Architect as a tool and Troux Semantics as notation. We modelled the different planned ways how MyKosmos would be used by the future users. This resulted in process model-like scenarios, as depicted in Figure 2 showing the example "distributed study formats: assignment work".

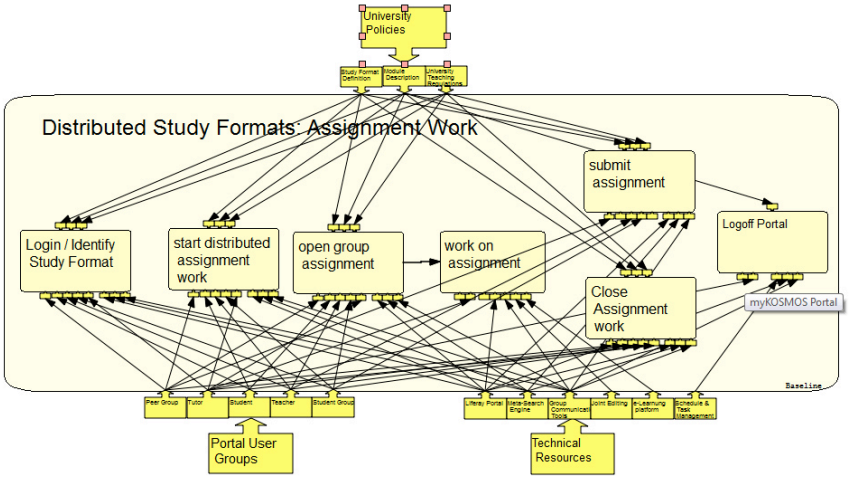

Fig. 2: Process model (excerpt) for new study format

The scenario starts with the student logging in. According to his profile he is provided with an individually configured entry page, making offers for his learning process. Following his course of study, completing different modules within the study format, the student choses to open or proceed with his assignment work for a certain module, which is loaded presenting the recent state of his work in progress. Once having caught up with his recent results, the student is confronted with different tasks to be fulfilled in order to fulfil the assignment, however is free to choose which task to pick. A regular assignment the designed study formats includes information research the portal supports providing the appropriate sources for the study format. In addition many assignments also involve the communication with fellow students since they are assigned group work. In the process the work should be documented to be handed in, where the kind of documentation being determined in the assignment description.

During the work process coordination issues between the team members should be resolved as well, which might be due to the individual time tables and working hours, as well as the specific interests or responsibilities within the task assignment. At the end of each session the user has the choice between submitting his work for the correction process and simply closing it to proceed in another sessions.

6 Summary

The paper investigated digital transformation from the perspective of higher education organizations and investigated general transformations paths and their implementation. We argue that enterprise architectures form an excellent support for planning the transformation and that portals are a suitable support for implementing the transformation. This statement is supported by experiences from Rostock University and the development and use of the MyKosmos portal.

The limitation of this work is that the digital transformation paths should be described in much more detail and investigated in many more case. A description in much more detail should include the objectives and steps of transformation activities and an analysis of all enterprise architecture layers including visualisation of effects of these digital transformation steps across all layers. The dependency on only a single case of transformation should be remedied by involving other higher education organizations also. This is at the same time the most important future work in the field.

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