Competence Approach to Modeling and Control of Students' Learning Pathways in the Cloud Service

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Abstract. The paper deals with the advantages of competence management in the implementation of the universities' development strategy. The competence approach has been used to model and control students' learning pathways by means of cloud service. The authors offer a model of university competence management, showing the interrelations between its components. The study of the university competences enabled the authors to describe the fragments of business models within the educational process management frameworks. The paper explains how to model and control students' learning pathways using cloud tools and technologies. For the purpose of this research the cloud service has been created in the Erlang OTP framework deployed in AWS EC2.

Key Words. Competence Management, Core Competence, Business Process Management, Learning Pathway, Cloud Service

Key Terms. Educational Process, Project Management, Business Process Model and Notation, Business Process Execution Language, Knowledge Management

1 Introduction

The features of University of the Future are the use of new technologies, the creation of a virtual educational space and the ability to sell its services on the market. Cloud technologies are one of the leading trends in today's IT world. They will bring both the university educational processes and business management system to a new quality level. Today more and more educational processes become adapted to cloud environment that provides lower cost of investment and workflow organization [1, 2].

Presently, the most popular cloud services are electronic document management software and data storage [3]. Electronic workflow that uses a single cloud platform becomes a major constituent of effective university management all over the world, especially in in view of the fact that numerous training centers are located in different countries and on different continents.

Today, a learning pathway becomes the main concept of educational process. The learning pathway is described as the route, taken by an individual learner through a range of e-learning activities. It allows learners to accumulate their knowledge progressively. With learning pathways, the control of choice moves away from the tutor to the learner [4, 5]. The learning process management performed via the control of learning paths is a complex task that requires creation of a uniform information environment. In addition, there is a large amount of structured information that is collected, processed and exchanged by the university information systems e.g. accounting and ranking of students and employees, curricula and syllabi, timetables, electronic grade books.

The concept of Business Process Management (BPM) for the university [6] requires consideration of the business processes running within its main framework, namely, management of educational and research processes, financial and administrative activities that come as special resources, continuously adapted to regular changes in accordance with modern standards of professional education and labor market requirements. Thus, data, applications and people become integrated through unified business processes. To illustrate, Charles Sturt University has made an attempt to form the Higher Education Process Reference Model that defines the core and support processes for the university [7, 8]. The core processes fall within Discipline Profile, Learning and Teaching, Research and Graduate Training. The support processes include Planning, Governance and Enabling processes. However, it should be noted that Business Process Model and Notation (BPMN) has not been used for modeling the above processes. That is why it is still not clear how a comprehensive BPM has been designed and deployed using, for example, the Business Process Execution Language (BPEL).

In addition, it is necessary to comprehend in theory and practice how professionally competent university teachers can contribute to marketable competences and skills of alumnae and unique core competences of the university itself [9, 10]. The University Core Competence is a leading competence governing the creation of a competitive educational product as a result of a unique research and educational activities. The Core Competence is a collective property of the teaching staff through which other competences and abilities (business processes) are organized and controlled, thus providing a synergetic effect, i.e. their systemic interaction.

Thus, the purpose of the present research is work out a concept of modelling and implementing the learning pathways for the university students. The learning pathways are based on the competence approach and come as business processes deployed and effectively controlled through the cloud service.

2 Competence Management in Strategic Development of University

One of the main tasks is to adapt the competence model to educational standards and business requirements, which is pre-conditioned by continuous improvement of both available business processes (*Business Process Management,* BPM) and development and implementation of innovative projects based on project management tools *(Project Management,* PM *).*

At that, the ongoing university business processes shape the job requirements, which in turn underlie the competence management. The analysis of strategically important business processes allows us to focus on the relevant core competences of the university. As for the BPM, the knowledge of a business process is a minimal and sufficient data-set required for the trained professionals to run this business process [11]. *Knowledge Management* (KM) is a basic component of the competence management framework within the university [12]. KM provides the conditions for identification, storage and effective use of knowledge and information within the university and its environment, including the competence of the university and its staff. The staff competences are described as a set of requirements to their knowledge, skills and qualities for a particular function, position or role in an innovative project (the latter may be part of new developments, start-up, new forms of interaction with companies etc.).

The knowledge management strategy is aimed to provide the departments and specialists of the university with the necessary knowledge on timely basis, if they need it to improve the efficiency of the university. This is done through the use of competence repository as the central link of the entire system. The repository will allow the staff to independently supervise, adapt and develop their individual competences, whereas the university will be able to control its own set of organizational competences. The university will enjoy the opportunity to smooth out the bottlenecks or gaps in the required competences by transferring some of the knowledge and skills from major specialists to other promising staff either through training or competence transfer mechanism.

The competence management is part and parcel of *Learning Management System*. Continuous learning is one of the core competences necessary for a university to develop in modern market. The competence management model is shown in Fig.1.

As a result of research, the developed concept lets us to present the process of competence management as a sequence of stages such as assessment, identification and description of competences necessary for successful strategic development of the university; definition of goals for the university development strategy based on internal and external competences; translation of the goals set into the *Key Performance Indicators* (KPI) that show if the strategic goals of the university have been achieved based on core competences; assessment and formation of competence profiles for various specialists; development of competence models according to the trends and objectives of the university development; comparison of specialists' profiles with the competence requirements of innovative projects; identification of the so-called gaps; curriculum planning and staff training or, if necessary, new staff employment according to the developed model and competence profiles; management, development and transfer of competences during the implementation of innovative projects.

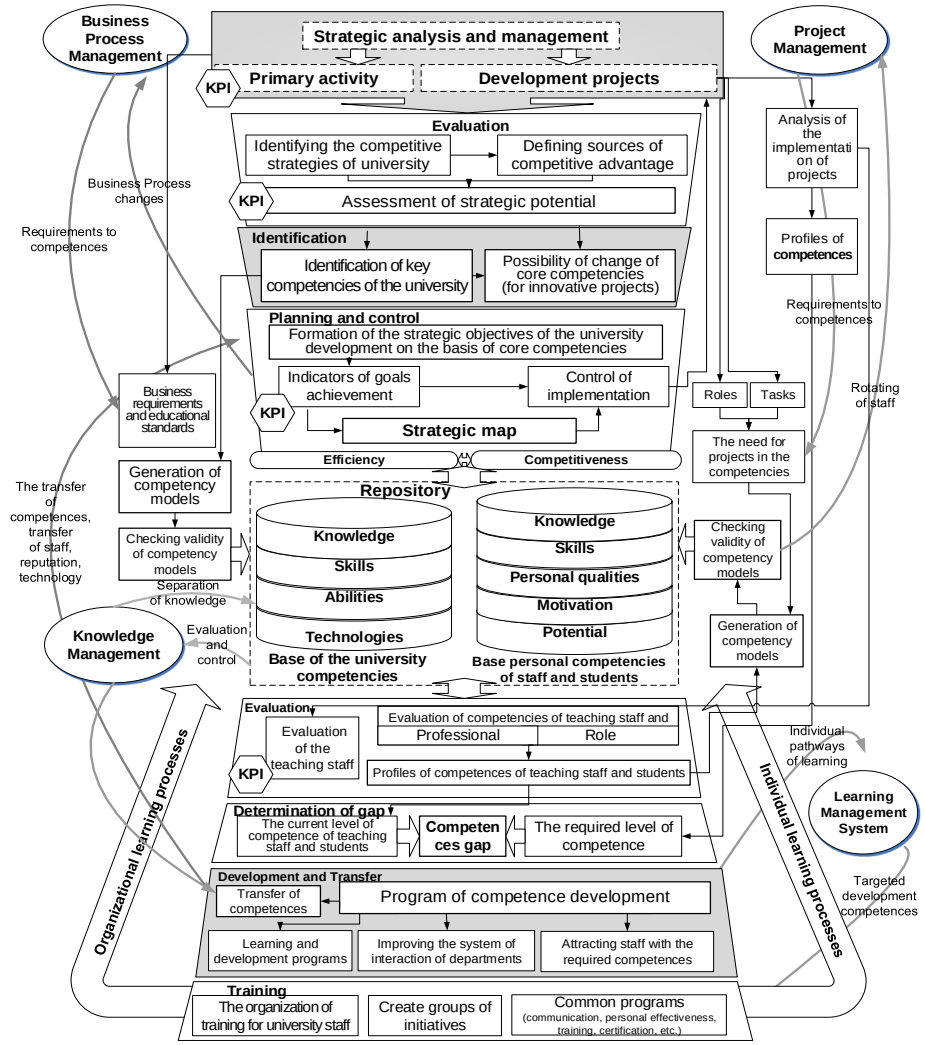

Fig. 1. Model of competence management at the university (Source: Own work)

Thus, core competences that come as resources and abilities are only potentially leading the university to success. They will only become efficient in a competitive struggle of the university, if transformed and embodied in the final educational product with a due account of parameters that are crucial for the market. To illustrate, the rapid development of IT has already greatly affected the staff of universities that train IT-professionals.

The strategic plan for the university development rests on the principle of reverse logic: firstly, candidates with core and major competences are found; secondly, the abilities (business processes) and the resources they manage are identified, and lastly, efforts are focused on further development of these two and other relevant constituents.

3 Modeling and Control of Students' Learning Pathways: System Vision

Taking into account the competence approach, our task is to monitor and control the learning pathways of university students more effectively. For this purpose, the learning pathways are modeled and set up as business processes within a public service.

National aerospace university "KhAI" has launched a project on modeling and automated execution of business processes within the management framework of the university educational process. The purpose is to monitor and control how successfully the BPM participants - teachers, other staff and students – perform their duties according to the project. Of particular significance are formalized learning pathways i.e. a sequence disciplines to be studied by the students, taking into account cloud-based competence approach in the format of BPMN.

The student's learning pathway has a starting point (admission to the university), the main path (academic activity) leading a student to the final point - defense of the graduate thesis. Thus, a university is provided with a uniform information environment, where students, teachers and senior staff can communicate easily. This enables individual planning, monitoring and management of learning pathways for the students. The participants in the process will automatically receive notifications and tasks sent to their own devices - laptops, tablets and smartphones.

4 Business Process Models for Educational Process Management Frameworks

After analyzing the educational processes within the university functional frameworks, we have built BPMN models to describe each automatic process running on a daily and weekly basis. To illustrate, a fragment of BPMN shows weekly processes (Fig. 2).

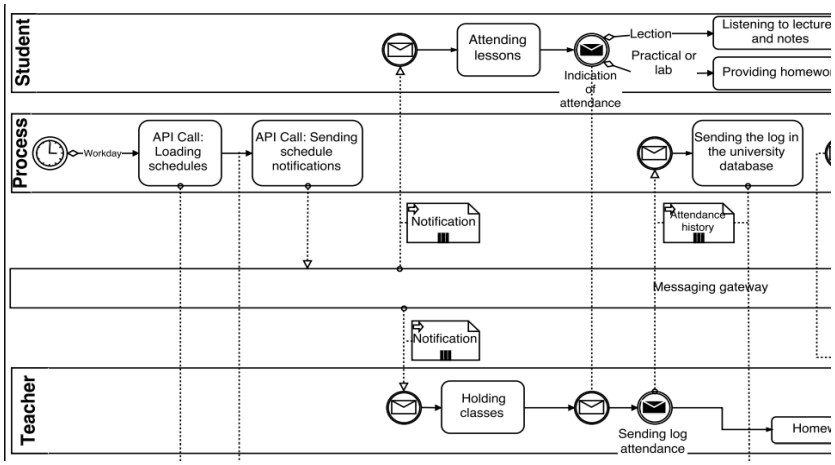

Fig. 2**.** A fragment of BPMN showing weekly processes (Source: Own work)

According to the diagram, the process contains several pathways, two of which simulate the staff (teachers and students) activities, one reflects the control process itself, and another one serves for sending e-mails and SMS, whereby the rest make up the Application Program Interface (API) of the university information systems. Thus, the logic of business processes is visualized, stored and performed in the cloud. In this way one can track the process execution phase, receive the task statuses in real time, analyze the data in course of the process execution, automatically generate and view summary reports of any profile, and receive the information about the bottlenecks of the process for taking appropriate corrective measures. This approach makes the process highly adaptable and provides an opportunity to make changes on-the-fly i.e. it is sufficient to make changes to the graphic model and restart the process, as the participants will receive tasks in accordance with the new process flowchart.

5 Cloud Service Tools and Technologies for Business Process Management

The cloud services intended for business process management in various institutions include IBM BlueWorks Live, AWS SWF, Appian, BPM Online Education, Corezoid, PNMsoft Cloud, and Oracle Process Cloud Service. The results of their comparison are shown in Table 1.

Table 1. Comparison of cloud services for business process management

Service	Price	Trial version	BPMN support	Education Process Management
Corezoid	$50 per 50,000,000 process executions	+	-	-
AWS SWF	$0.0001 per one process execution	+	-	-
IBM Blueworks Live	$21 per month	+	+	-
Appian	a minimum of $225	+	+	-
BPM Online Education	a minimum of € 200	-	-	+
PNMsoft Cloud	depends on the number of users and processes	+	-	-
Oracle Process Cloud Service	$1,200	+	+	-

Virtually all services have trial versions. The only service exclusively designed to manage learning processes is BPM Online Education, whereas IBM Blueworks Live, Appian and Oracle Process Cloud Service allow modeling of processes in BPMN. At our university we plan to use AWS SWF because its price is reasonable and it can perform all the basic required functions.

The architecture of the system for modeling and control of students' learning pathways in the cloud services is shown in Fig. 3. It includes three main elements such as a cloud service where processes are executed, a web application that is intended to design services, and the university API with its information systems. The web application is created in the MeteorJS framework, which allows one to develop both front-end and back-end interfaces using the same logic for each. The bpmn.js library is used to work with BPMN diagrams. The library helps to create a module designed to transform the descriptive BPMN model into a scenario of its execution based on Business Process Execution Language (BPEL).

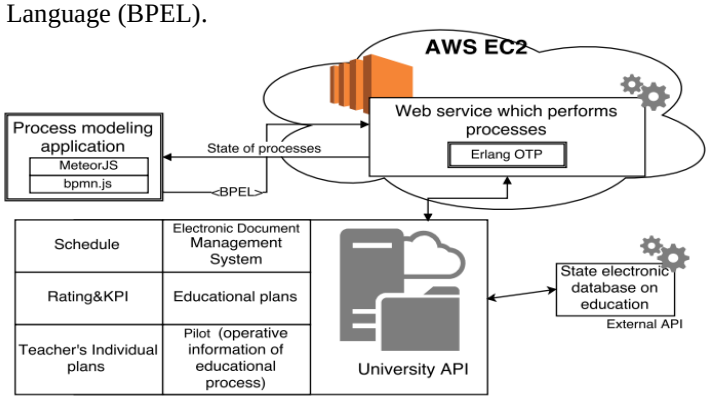

Fig. 3. The architecture of the system for modeling and control of students' learning pathways in the cloud services (Source: Own work)

6 Results

The cloud-based system of educational process management has been only recently introduced and therefore the overall deliverables are expected in the nearest future. Presently, the KhAI is trying to combine separate educational frameworks within a single platform connected to the cloud web service. The ability to control each running education process has shown positive results. Thus, the time required for curriculum planning, academic ranking, and teacher workload balancing has decreased by about 25%. The time is mainly spent only on entering and updating the information. This contributes to minimization of all the computing and control procedures of the educational process. The long-time exploitation of the cloud-based system of educational process management and additional research will enable the estimation of its efficiency.

7 Conclusion

The introduction of core competences in the system of strategic university management helps the university to increase its competitiveness, achieve positive synergetic results in implementing innovation projects, and adapt to new economic conditions. The expected benefits of the approach offered consist in formalization and harmonization of business processes (educational process, research and administrative activities);

unification of business processes where data, applications and staff/students become integrated; creation of a uniform information space; transfer to individual planning, monitoring and control of every student's learning pathway within the university etc.. This allows the university to run transparent business processes and detect the conditions that can be easily monitored, analyzed and optimized. As a result, the educational process becomes easy, entertaining and advanced.

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