Masaryk University
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E-learning in Process-oriented Knowledge Management

Ph.D. Thesis Proposal

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Chapter 1

Introduction

Knowledge has become an important resource for organizations. Knowledge management is becoming one of the key disciplines in management, especially in large companies and the need for an effective management of knowledge is gaining increasing recognition in today's economy. To acknowledge this fact, new promising and powerful technologies have emerged from industrial and academic research. In Economist 2007 survey, CEOs have stated that knowledge management is the most important investment in realizing corporate strategy goals [84].

Challenged by growing competition in a globalising environment, organizations are seeking to find efficient methods to allow shared access to their key resources: knowledge, experience and ideas. The combination of knowledge management and electronic learning (e-learning) is a response to this challenge. The use of information and communication technologies (ICT) as teaching and learning tools is now rapidly expanding into education and e-learning is one of the most popular learning environments in the information age. As information technologies develop, novel ways of teaching and learning environment have emerged, it creates opportunities in university and corporative training. Many universities and corporations have used e-learning as a new way for teaching and training. Thus, e-learning efforts and experiments currently receive enormous attention across the globe. The growth of e-learning is directly related to the increasing access to ICT and its decreasing cost as well.

Growing numbers of teachers are increasingly using ICT to support their teaching. The contemporary student population (often called the "New Millennium Learners", "Net Generation" or "Millennials") who have grown up using ICT also expect to see it being used in their educational experience.

Although a significant number of technology-enhanced learning standards and specifications have been produced in the last decade, access to educational content remains limited. The lack of accessibility and interoperability of digital learning resources and learning technologies adversely affects content developers, technology providers, educators, and learners.

So far much research has been devoted to constructing e-learning platforms, producing e-content, describing it with metadata, but less attention has been paid to using the technology to improve the learning process in terms of depth and scope. The challenge is not to use new technologies to re-create traditional education systems, but rather create new learning environments, providing improvements to both teachers and students, and enhance the quality of education [60].

Although process-oriented knowledge management is a relatively new approach of knowledge management which itself is a rather new term and includes a variety of concepts and approaches tackling a very diverse field of challenges, this approach has been applied into many areas, including public administration, supply chain simulation, work flow, software development, product design, security management, device management, etc. Most of the researches concerned about organizational core business processes and managed the important knowledge assets for enhancing the business core competencies. In knowledge management practices, the process-oriented view offers a number of advantages, such as orienting knowledge management towards organizational realities, tracing knowledge flow along with the value chain, providing knowledge application with contexts, aiding navigation of existing information systems, and particularly facilitating easy access and application of the knowledge resource for daily work.

This thesis proposal elaborates on a novel approach to process-oriented e-learning. Its novelty does not lie in introducing new technologies or paradigms. Rather, it explores the potential of putting together a set of well-known technologies in an uncommon way. The goal is to deliver methodology and environment for defining transparent learning processes that can be easily managed and monitored and allows teachers/tutors/knowledge managers to measure effect of education.

The research question posed in this thesis proposal is whether it is feasible to apply process-oriented approach to e-learning processes within knowledge management, if so, what are the potential benefits and limitations of taking this way.

The research is expected to contribute to improvement of implementation of knowledge models, providing a tool and methodology to represent knowledge as process-control knowledge in the domain-specific area. Proposed methodology will be applicable to process-oriented industries since it employs a process-oriented approach in capturing and sharing knowledge.

This thesis proposal is organized as follows. Firstly, in Chapter 2, we discuss the use of e-learning as a tool of knowledge management and existing methods, methodologies and techniques related to learning process management and modeling. At the end of Chapter 2, there are mentioned projects that are dealing with process-oriented approach in learning processes. The Chapter 3 outlines the concept of the Research proposal and further study plan.

Chapter 2

State of the Art

This chapter describes state of the art in areas important to the research. There are mentioned relevant information sources and publications related to my research. We will briefly outline the connection of knowledge management, organizational learning and e-learning; mention existing conclusions and related methodologies and techniques and process measurement related to the process-oriented approach to knowledge management and e-learning, respectively to the learning process and also mention the learning patterns as a key element of learning process modeling.

2.1 Preliminaries

2.1.1 Knowledge Management

There is no strong consensus on the terminology of knowledge management from the knowledge management practicioners' point of view [75].

Knowledge management (KM) is a cross-disciplinary domain and draws from a wide range of disciplines and technologies, such as Cognitive Science, Artificial Intelligence, Groupware, Library and Information Science, Technical Writing, Document Management, Semantic Networks, Relational and Object-oriented Databases, Simulation, Management of Information and Management of people [70]. That is only a partial list, but covers the most important aspects of knowledge management.

KM is the system and managerial approach to the gathering, management, use, analysis, sharing, and discovery of knowledge in an organization or a community in order to maximize performance [11], in other words (and for purpose of this thesis proposal) we can understand the KM as the management of processes that govern the creation, dissemination, and utilization of knowledge by merging technologies, organizational structures and people to create the most effective learning, problem solving and decision making in an organization.

Although there is no universal definition of what constitutes knowledge, it is generally agreed there is a continuum of data, information, and knowledge. Data is mostly structured, factual, and oftentimes numeric, and reside in database management systems. Information is factual, but unstructured, and in many cases textual. Information basically refers to any content that can be communicated. It is independent of the size and format of the content or the method used to communicate it. Knowledge is inferential, abstract, and is needed to support decision making or hypothesis generation. Knowledge refers to content communicated in a context. In other words, knowledge includes information, as well as the context that makes the information useful and meaningful.

The concept of knowledge has become prevalent in many disciplines and business practices. For example, information scientists consider taxonomies, subject headings, and classification schemes as representations of knowledge. Consulting firms also have been actively promoting practices and methodologies to capture corporate knowledge assets and organizational memory [12].

For being successful, it is indispensable to link knowledge management with business process management [63], to integrate KM into the daily activities of the employees. Jablonski et al. [33] proposed integration of KM and process orientation, aiming at the integration of process-oriented KM and work flow management[1]. Process-oriented KM aims to provide employees with task-related knowledge of the organization's operative business processes. In this environment, knowledge can be offered to an employee in a much more targeted way. Therefore, process-oriented knowledge management means developing solutions with business processes as basis. Considering that reusing and sharing are the core ideas of KM, they raised the following basic issues: classification of knowledge carriers, connection of knowledge carriers, and openness of a knowledge base.

More process-oriented definition of knowledge management definition can be found in [88]: "KM is the systematic management of all activities and processes referred to generation and development, codification and storage, transferring and sharing, and utilization of knowledge for an organization's competitive edge".

The objective of KM is to improve the quality of the contributions people make to their organizations. This is achieved by helping people to make sense of the context within which the organization exists, to take responsibility, to cooperate and share they know and learn, and to effectively challenge, negotiate and learn from others [14].

There are two reasons why KM is so important: good knowledge management can reduce the need for training and demand for training tends do decline over time, while demand for knowledge stays constant or even grows [73].

Improved organizational behaviours, decisions, products, services, processes and relationships that enable the organization to improve its overall performance are the "intermediate outcomes" of KM [39].

2.1.2 E-learning and Learning Management System

Nowadays, there seems to be little consensus about what the term e-learning means. It can describe a wide range of applications, and it is often by no means clear even in peer reviewed research publications which form of e-learning is being discussed [53].

E-learning is commonly referred to the intentional use of information and communications technology in teaching and learning. A number of other terms is also used to describe this mode of teaching and learning. They include online learning, virtual learning, distributed learning, network and web-based learning. Fundamentally, they all refer

[1]Traditional business process management systems are effective in providing coordination support, but are not geared towards providing relevant knowledge support as well. Also, knowledge management systems are used in an ad hoc manner without explicitly linking them to the underlying organizational processes. Process-oriented knowledge management systems have emerged as a potential solution to support integration of KM and business process management.

to educational processes that utilize information and communications technology to mediate asynchronous[2] as well as synchronous [3] learning and teaching activities.

In 2001, Rosenberg suggested the following definition of e-learning: "the use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance." [73] By OECD [23] the concept of e-learning is defined analogously. Khan [40] defines that e-learning encompasses Web-based learning (WBL), Internet-based training (IBT), advanced distributing learning (ADL), and online learning (OL). Moreover, by another definition, e-learning includes instruction delivered via all electronic media such as the Internet, intranets, extranets, and hypertext/hypermedia documents [28].

Indeed, e-learning extends traditional learning paradigms into new dynamic learning models through computer and Web technologies.

However, Bates and Poole [6] argue that when instructors say they are using e-learning, this most often refers to the use of technology as classroom aids, although over time, there has been a gradual increase in fully online learning.

The term e-learning 2.0 was coined by Stephen Downes, a Canadian researcher, and it derives from the overall e-learning trends stated above in combination with Web 2.0. From an e-learning 2.0 perspective, conventional e-learning systems were based on instructional packets, which were delivered to students using assignments. Assignments were evaluated by the teacher. In contrast, the new e-learning places increased emphasis on social learning and use of social software such as blogs, wikis, podcasts and virtual worlds such as Second Life [71].

Blended learning (also called hybrid learning) is the term used to describe learning or training events or activities where e-learning, in its various forms, is combined with more traditional forms of training such as "class room" training. A significant advantage of blended learning is the ability to take into account and to cater for individual needs. An individual could receive additional information and training through extra e-learning programs whilst still attending class room training with other students

Benefits and Importance of E-learning

Mouzakitis [74] discusses the following advantages of using e-learning in training activities: cost-effectiveness; productivity improvements; faster learning; better retention; customer satisfaction and employee increased satisfaction; and facilitation of self-paced learning.

Some of the benefits of e-learning include consistency of content, ease of customization, learner control, and reduction or elimination of travel costs to attend learning events. Because of its digital nature, e-learning can be cost and time-effectively customized to individuals or small groups. The same content can be offered in a multitude of formats:

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[2]Meaning that learners are experiencing the learning at different times – these activities use technologies such as blogs, wikis, and discussion boards. The idea is that participants may engage in the exchange of ideas or information without the dependency of other participants involvement at the same time. E-mail is also asynchronous in that mail can be sent or received without having both the participants' involvement at the same time. Asynchronous learning also gives students the ability to work at their own pace. This is particularly beneficial for students who have health problems. They have the opportunity to complete their work in a low stress environment.

[3]Meaning that learners are experiencing the learning at the same time – these activities involve the exchange of ideas and information with one or more participants during the same period of time. A face to face discussion is an example of synchronous communications. In an "e"-learning environment, an example of synchronous communications would be a skype conversation or a chat room where everyone is online and working collaboratively at the same time. Synchronous activities occur with all participants joining in at once, as with an online chat session or a virtual classroom or meeting

self-paced, facilitated, in the classroom, blended. Also because of its digital nature and the flexibility provided by intranets and the internet, travel costs are greatly reduced or eliminated since learners do not have to congregate in one spot for a learning event. "It cuts travel expenses, reduces the time it takes to train people, and eliminates or significantly reduces the need for a classroom/instructor infrastructure [73]."

The importance of e-learning may be summarized as it incorporates the traditional pedagogy of education with the advantages of technology to capture, disseminate and share knowledge throughout an organization [39].

Learning Management System

As a consequence, the dominant learning technology employed today is a type of system that organizes and delivers online courses — the learning management system (LMS). This software has become almost ubiquitous in the learning environment. The learning management system takes learning content and organizes it in a standard way, as a course divided into modules and lessons, supported with quizzes, tests and discussions, and in many systems today, integrated into the college or university's student information system.

LMSs range from systems for managing training records to software for distributing courses over the Internet and offering features for online collaboration. In many instances, corporate training departments purchase LMSs to automate record-keeping as well as the registration of employees for classroom and online courses. These systems are very important in education. LMS can offer many benefits. It provides uniform learning content, enriches the learning experience, increases student participation, manages content delivery and, by using standardized content formats, users can share course content. The business use of an LMS can also reduce training costs, increase employee competency and the flexibility of a training agenda, decrease employee turnover, and manage learning facilities in conjunction with human resources goals.

An LMS may contain information about how long it would take to work through self-study material and the length of face-to-face courses. An LMS may give immediate access to e-learning material, it may enable people to register for a face-to-face course, and it may dispatch other forms of study material. An LMS may monitor progress and provide a record for learners on how they are doing, perhaps against their own original target or against others. For the learner, the LMS gives access, feedback, and a planning tool [29]. As LMSs continue to evolve and gain popularity, further research is needed to help instructors and students identify the most effective ways to use these technologies to improve teaching and learning, and not only in higher education but also in business.

Rosenberg [73] discusses the infrastructure and technology considerations for succeeding in e-learning. According to him, any e-learning strategy is doomed to failure without adequate access to the Internet. In addition, the level or speed of connectivity and the learning platform to be used must be considered. The LMS is another consideration and is essential to allow employees and employers to manage and evaluate the learning process.

2.2 E-learning as a Tool of Knowledge Management

The speed at which new products, services and features are introduced means that employees have to learn and consolidate new information more and more rapidly. Educating these workers in an efficient and effective way becomes critical to the KM of an organization since organizational survival depends on the service provided to customers and much of this service requires up-to-date knowledge of new products and their changing features.

Organizations have embraced the notion of "knowledge" as an asset that creates value when shared. Organizations worry less about training workers and then having them leave and more about not training workers and having them stay. This makes the corporate training/knowledge management market the most promising for e-learning [87].

Maurer and Sapper [62] argued that e-learning has to be seen as a part of the general framework of knowledge management.

Rosenberg [73] identifies knowledge management as a key in creating a culture for e-learning. In speaking of knowledge management, he stresses that support to move in the learning-through-technology direction must be championed by management—especially front-line managers must be on board for success to be realized. An effective knowledge management system not only provides a vehicle to share information, but also builds a community of learners. The employee can use their computer to view company policies, access forms, distribute information among colleagues, share stories, access expertise of respected sages, trouble shoot, gain up-to-the-minute advice, teach, coach, and customize one's training needs. The author stressed the importance of building a culture of learning where learning is perceived and used as a natural piece of one's job.

Properly developed, e-learning creates a growing repository of knowledge that will continuously deliver to employees just what they need to know at any particular moment, and in a style that each individual can understand. E-learning at this level is similar to its efficiency counterpart in inventory management; it can be thought of as "just in time learning". In short, e-learning permits participants to acquire knowledge, to pass it from one person to another, to apply it to organizational problems/opportunities, and to store that knowledge for future use. If this sounds familiar it is because, essentially, knowledge management and e-learning are both about knowledge generation (acquisition, creation, capture, and adoption), knowledge storage, knowledge distribution, and knowledge application [39], [87].

But first, several considerations must be taken into account for e-learning to be a lucrative investment and an effective KM tool. The elements of the e-learning planning process include assessing and preparing organizational readiness (factors to consider before going online), determining the appropriate content (content that ties into the goals of KM), determining the appropriate presentation modes (considering factors contributing to effective e-learning) and implementing e-learning (content and technology infrastructure considerations). Despite the challenges involved in creating a successful e-learning environment, it is clear that the benefits of e-learning complement and strengthen other KM activities [87].

Convergence of KM and E-learning Systems

Knowledge management and e-learning are both approaches that intend to improve construction, preservation, integration, transfer and (re-)use of knowledge and competencies. Both of them address the same fundamental problem: facilitating learning in organizations. Both of them have some other significant overlapping areas such as technologies, goals, processes, people and contents and some opportunities for mutual sharing, exchanging and adopting [31]. It is inevitable that the KM and e-learning technologies will converge. Too many necessary links between the two disciplines exist, and most systems already encroach on the territory of the other. As the management of intellectual capital becomes more mission critical, unification will be a welcome occurrence [66]. The convergence of e-learning and KM fosters a constructive, open, dynamic, interconnected, distributed, adaptive, user friendly, socially concerned, and accessible wealth of knowledge [56]. E-learning has become a significant step in the development of KM systems. Morales [65] contended that KM and e-learning are closely related because e-learning users need a suitable KM that can help them to obtain the kind of content they need, together with as correct and complete information as possible. KM oriented e-learning has become the effective tool that transfers tacit knowledge information into explicit knowledge, as a result, organizations with this system can accomplish knowledge and information delivery in or between organizations [51].

Chunhua [15] discusses e-learning as a new approach to KM. In his paper, the synergies are shown as using e-learning as a tool to help internalize tacit knowledge; using e-learning as a way to acquire knowledge; and applying e-learning to promote knowledge sharing. E-learning in this regard can be seen to be part of organizational learning in which KM plays a role in the knowledge acquisition, sharing, and application phases as well.

Lamont [46] observes and discusses that e-learning has not reflected a strategic, enterprise-wide vision, but has more of a tactical and departmental focus. KM, on the other hand, reflects a more strategic view of the organization. According to Lamont, some scholars and practitioners see e-learning migrating to become a part of KM; others see KM as a tool to be used in an e-learning process. Certainly, reusable learning objects (or knowledge objects) allow learning content to be chunked into smaller units whereby LMS can provide support for the use of these learning objects in the development of courses. Companies such as Cisco, have committed to using reusable learning objects over the years too.

Chen and Hsiang [13] studied the importance of developing a knowledge community through e-learning as a critical element in implementing KM policy. E-learning, they argue, should help to nurture a learning organization and foster a corporate culture based on knowledge sharing.

Other researchers have demonstrated how combining KM and e-learning through the use of intelligent systems increases organization performance [18], while Shaw [78] shows that tools such as knowledge maps can improve one's e-learning performance. Knowledge maps are similar to concept maps in showing visualized concepts, knowledge, and relationships.

A common linkage between KM and e-learning is the use of learning/knowledge objects. According to the Web-Based Training Information Center[4], learning objects are the trend that will have the biggest impact on online learning in coming years. The goals of learning object design are [WBtIC]:

- Reusability: Learning content is modularized into small units of instruction suitable for assembly and reassembly into a variety of courses.
- Interoperability: Instructional units that interoperate with each other regardless of developer or learning management system.
- Durability: Units of instruction that stay the course and ever evolving delivery and presentation technologies without becoming unusable.
- Accessibility: Learning content that is available anywhere, any time-learning content that can be discovered and reused across networks

[4] `http://www.wbtic.com/trends_objects.aspx`

By packaging these learning objects within e-learning, online learning can become more powerful and agile. If some of these learning objects are actually "knowledge objects," whereby the learner has access to interactive pools of knowledge, then the learner can augment personal knowledge through these knowledge bases for a deeper understanding of specific knowledge [48].

KM and e-learning systems share many features. Some of these are as follows [19]:

- System architecture is almost the same for both concepts. It is a client-server-architecture with high complexity in the server-part whereas the thin clients are mostly used.
- Collaboration and communication — For both systems, it is very important to provide support rather rich communication and cooperation features. Different kinds of synchronous and asynchronous communication are possible. These vary from e-mail over chats to forums or other forms of cooperation
- Personalization plays an important role for both approaches. Relevant systems for both concepts support some kind of personalization either role-based or person-oriented. The working environment can be adapted to the user needs and characteristics. Both systems are not closed or isolated. Information is most often shared among several resources and can be changed, extended, modified or removed on demand.
- Access rules — In both worlds, users need to be identified by the system. They are attached to a defined profile and they are given access to relevant information only. Most often, different layers of access rights enable the control of information access. It is very important to provide only specific information to specific users or groups.

There are also differences. The most important difference is that e-learning systems and knowledge management systems are focused on two totally different goals. E-learning systems try to support learners in expanding their knowledge by providing structured learning content and intercommunication facilities to specific topics while knowledge management systems provide knowledge by using content management systems with search and sort facilities and in addition some kind of collaboration with experts and other users on various topics [70].

One of the most important goals is to design content that can be used for both systems to get a better conjunction between these two concepts. E-learning content should not be just content designed to teach people but provide information in a sorted and structured context. This is exactly what knowledge management systems need and try to do. Content of the KM system can be seen as a kind of repository for content used in the e-learning part. Only additional and specific metadata is needed.

Metadata is structured information that describes, explains, locates, or otherwise provides easier way to retrieve, use, or manage an information resource. An important reason for creating descriptive metadata is to facilitate discovery of relevant information. In addition to resource discovery, metadata can help organize electronic resources, facilitate interoperability and legacy resource integration, and provide digital identification, and support archiving and preservation. Some authors classify the representation of metadata in e-learning applications into three categories: standard metadata, semi-semantic metadata, and semantic metadata but the trend nowadays is to use semantic metadata for its flexibility, extensibility, and reasoning which leads to pleasing results in facilitating large scale collaboration [76].

KM is nowadays considered to be an important and arguably necessary, tenet of modern day business strategy. The frequency with which knowledge workers change positions and jobs underscores the urgency for organizations to capture and distribute the knowledge of its intellectual assets to better position organizations to survive and thrive. E-learning is a promising means to this end, however, to be effective it requires careful planning.

A combination of the advantages of both domains facilitates the delivery of high-quality education for satisfying the specific educational needs of team members. E-learning is definitely growing rapidly and is becoming the most common method of delivering education. In spite of some obstacles and limitations in the immediate implementation, it is clear that knowledge management and e-learning are the way of the future in the field of distance online education [69].

2.2.1 Process-oriented Approach in KM and E-learning

Better utilization of organization internal experience and knowledge or to say it in other words the demand for an optimal reuse of technology and skills within an organization is implied by need to exploit skills and technology that are already available in an organization. There are two areas where the reuse of technology and skills is facilitated appropriately – business process modeling and knowledge management [33].

Business process modeling shows several facets. Firstly, it describes how business processes are performed in order to provide a template for future executions of these business processes. Thereby, their improvement is an issue permanently. Thus, experience about how business processes are executed optimally is reused in future deployments. Secondly, business processes prescribe how given resources are optimally utilized in order to perform applications. One of the major goals of business process modeling has been the optimization of throughput and responsiveness of industrial applications.

As it was said before, KM is a means to manage the know how and experience of employees. The objective is to treat knowledge as a valuable resource as condition for the learning enterprise. When we combine both approaches, both concepts should leverage on each other in order to eliminate their drawbacks such as that knowledge is not directly associated with a concrete business process and cannot be handled properly [33].

A commonly used term to describe relatively young research domain is "Process oriented Knowledge Management (PoKM)" [33], [64] which includes a variety of concepts and approaches tackling a very diverse field of challenges. PoKM approaches predominately focus on Process Modeling, Process Learning, Process Support, Process Execution or Process Improvement. PoKM approaches mainly focus on one, but cover and typically need to resolve more than one of the identified challenges [80].

Work flow Management Coalition (WfMC) defines a (business) process as [79]: "A set of one or more linked procedures or activities which collectively realise a business objective or policy goal, normally within the context of an organisational structure defining functional roles and relationships."

Work flow technology allows building information systems that offer the right tasks at the right time to the right person along with resources needed to perform these tasks [49]. Therefore, process management technology or work flow technology can be a foundation in e-learning architecture and used to shift the paradigm from task-oriented e-learning to process-oriented e-learning [50].

KM and process orientation are well-established techniques. Nevertheless, their practical use still shows some severe deficiencies (see [33]). To solve these problems, therefore, Kim in [41] proposed a concrete method of analyzing knowledge flow by using a process-oriented approach. They focused on knowledge flow, during which knowledge is transferred from one process to other processes. It is crucial to model and manage knowledge flow among knowledge workers and the process-oriented approach helps workers to associate knowledge with its related processes.

Maier and Remus [57] suggest a process-oriented knowledge management approach as a step to bridge the gap between human- and technology-oriented KM. This approach is outlined with the help of the four levels of intervention: (1) strategy, (2) KM organization and processes, (3) topics/content, and (4) instruments/systems.

As Maier and Remus [58] noted in their research, the process-oriented view offers many advantages. Processes can provide part of the context that is important for the interpretation and construction of process relevant knowledge. This includes knowledge about processes that is to be stored together with the knowledge derived from processes during their operation.

According to Kwan [45] in process-oriented KM, each KM project is developed around an organizational process and the mission, rationale and objectives of the process define the scope of the project. This process orientation is justified by the fact that process knowledge is believed to be the source of the core competence of an organization. Process-oriented KM ties the value of KM to process performance by defining the scope of the KM project around a strategic process.

At the heart of the process-oriented KM strategy is a knowledge management system (KMS). KMS has a work flow management subsystem that enables it to capture knowledge in context as it is created and present knowledge to the user at the right step of the process. Its repository contains not only knowledge created and manipulated in an organizational process, but also the knowledge of the process itself in the form of process designs, case histories and lessons learned from past experience [45].

Liu and Yang [50] proposed an e-learning system architecture which considers the concept of process management and the applications of mobile device for supporting this pedagogical method. This kind of e-learning system could reduce teacher's workload, streamline teacher's teaching process and student's learning process, and, moreover, offer personalized e-learning services based on the instruction theory.

2.2.2 Process-oriented Knowledge Management Systems

Process-oriented knowledge management initiatives are aimed to avoid the problems of "core rigidity" in the case of resource-orientation and strategic overstretching of competencies in the case of market-orientation [25]. Practical knowledge management is technology dependent. The appropriate technology, applied judiciously to the proper phase of the knowledge processes, can significantly improve the efficiency and effectiveness of knowledge management. Typical knowledge management systems are content management, yellow pages, process communities and knowledge networks, knowledge maps, lessons learned and best practices.

Related studies were carried out to develop PoKM systems by integrating the existing knowledge systems. The InfoAtlas project developed an Information System Map for the daily work by providing the descriptions of all the information systems of an organization together with the necessary infrastructure [82] and in PROMOTE [37] this approach was extended for building a methodology and a product integrated in the framework of business process management. A prototype system of process-oriented knowledge management was presented in [33], the knowledge base of which handled pointer references to external knowledge carriers. The knowledge carriers are arbitrary documents which might be stored in any system. A framework was proposed in [35] which supported the life cycle requirements of both knowledge processes and business processes by integrating existing knowledge management systems and business process management systems.

2.3 Existing Methods, Methodologies and Techniques

2.3.1 Measurement Approaches

There are two things that all organizations should keep in mind as they develop measures and metrics. Firstly, it is extremely difficult to create any measure of knowledge sharing that will show an absolute one-to-one correlation between a knowledge-sharing action and a business result. Much like measuring the success of training and development programs, measuring the impact of knowledge sharing requires correlation and some assumption. Second, to truly understand the impact of knowledge sharing and reuse, an organization must first understand the baseline business or process performance before beginning KM efforts, because if you do not know where the starting line is, then you cannot say what your time is at the finish line.

Measuring the KM

Sound planning, savvy marketing, high-quality products and services, attention to customers, the efficient structuring of work, and the thoughtful management of an organization's resources is not diminished in importance by the acknowledgement that knowledge is critical to success and needs to be managed. However, when a business faces competitors that perform well on those other dimensions, the difference between success and failure may well turn on how effectively it manages its knowledge. Knowledge management success factors may be links to economic performance or industry value; a technical and organizational infrastructure; a standard, flexible knowledge structure; a knowledge-friendly culture; a clear purpose and language; a change in motivational practices; multiple channels for knowledge transfer and senior management support [17].

The effectiveness of KM depends on how the generation of new knowledge is organized and how existing knowledge is transferred throughout the organization.

Organizations often waste their resources and lose a significant amount of money by repeating the same mistakes, duplicating projects and being unaware of each others' knowledge due to the lack of knowledge transfer and sharing throughout the organization. Nonetheless, knowledge transfer is not a one directional movement of knowledge. Effective knowledge transfer is more than the movement of knowledge from one location to another. It is proposed that organizations can gain significant learning benefits through transferring knowledge between units and people [72]. It tends to improve competence of both sides that transfer and share knowledge. This is because knowledge does not leave the owner when it has been transferred. As a result, the value of knowledge grows each time a transfer takes place and the key to value creation lies in how effective knowledge has been transferred throughout the organization [81].

The measurement of KM efficiency in the organizations is in general done in two main ways; by "log in database" or by conducting "surveys". Both users, and their participation, are tracked in a database or users are asked to participate in a survey to show results from more qualitative areas. When attempting to measure more elusive aspects, the way to do this is no other than to ask people in surveys.

Practicing KM for years can produce various forms of knowledge asset (intangible assets or intellectual capital) in firms. Edvinsson [22] showed that the intellectual capital of a firm can be measured, documented, and monitored. Brooking [9] analyzed the multiple components of intellectual capital and provided lists of high-level questions useful for auditing an organization's intellectual capital. Kaplan and Norton [36] developed a Balanced Score Card (BSC) using a combination of measures in four categories (financial performance, customer knowledge, internal business processes, and learning and growth) to align individual, organizational, and cross-departmental initiatives. They expected that BSC would help companies test and update their strategy and meet their customer's needs and shareholder's objectives.[5] The evaluation of KM performance has become increasingly important since it promotes strategic organizational learning and generates the capabilities required to meet customer expectations.

Lee et al. [47] define knowledge management performance index (KMPI) as a logistic function having five components that can be used to determine the knowledge circulation process (KCP): knowledge creation, knowledge accumulation, knowledge sharing, knowledge utilization, and knowledge internalization. When KCP efficiency increases, KMPI will also expand, enabling firms to become knowledge-intensive[6].

¿From the performance indicator matrix proposed by [77], the technological aspects of KM are more explicit and generate a specific value, which can be used in for instance a Balanced Scorecard. These indicators are easy to measure by database logs, and since they generate specific values they are easy to compare in order to find out if the performance is increasing or decreasing. While the performance indicators related to the human aspects are a bit vaguer and often depend on a person's subjective opinion.

Zaim's study [88] examines the relationship between KM processes and KM performance. The empirical evidence shows that three main KM processes, namely, knowledge sharing and distribution, knowledge generation and development, and knowledge codification and storage, can be constituted into a useful model. In theory, it has been generally accepted that KM processes have great influences on KM performance. However, there is less empirical evidence verifying this acceptance. The findings of his study confirm the positive correlation between the processes and performance of KM. Knowledge sharing and distribution appeared to be the most significant process of KM practices whereas knowledge generation and development came next. It is possible that in the manufacturing sector, knowledge generation and development is the most important process of KM but in the services sector it is knowledge sharing and distribution that has the most significant impact on KM performance.

[5]It was found that BSC is the only established method identified to handle the result stemming from the quantitative indicators, originating from logs in databases. As for the qualitative performance indicators, they do not result in a value to put in the Balanced Scorecard, since they depend on the users' subjective views [77].

[6]A knowledge-intensive job or industry is one where the workers need a lot of education, skills, and experience in order to work effectively. Knowledge Intensive Business Services (commonly known as KIBS) are services and business operations heavily reliant on professional knowledge. They are mainly concerned with providing knowledge-intensive support for the business processes of other organizations. The main KIBS sectors according to the European Monitoring Centre on Change (EMCC) are Computer and related activities (HW and SW consultancy, Data processing etc.), Research and experimental development (on natural sciences and engineering , on social sciences and humanities), and other business activities (Legal activities, Accounting, etc.)

Measuring the Quality of Education

The World Declaration on Education for All (1990) and the Dakar Framework for Action (2000) — the two most recent United Nations conference declarations focusing on education — recognize quality as a prime condition for achieving Education for All. The Dakar Framework affirms that quality is "at the heart of education". It goes on to say, "What takes place in classrooms and other learning environments is fundamentally important to the future well-being of children, young people and adults. A quality education is one that satisfies basic learning needs and enriches the lives of learners and their overall experience of living." Despite a growing consensus about the importance of quality, there is much less agreement on what the concept means in practice. Two principles, however, characterize most attempts to define the quality of education. The first, which identifies learners' cognitive development as the major explicit objective of all education systems, sees the success with which learners achieve this as one indicator of their quality. The second emphasizes the role of education in promoting commonly shared values, and creative and emotional development — objectives whose achievement is much more difficult to assess [83].

One of the most important aspects to ensuring the rising quality of education, and not only in the academic sphere, is feedback from students to the teacher. Today many teachers use various online environments such as LMS systems. The feedback process without computer assistance is extremely time-consuming, and there is no complex reporting application that can be fully integrated into learning management systems and provide substantiated reports to teachers.

Educational research is tricky business. Methodologies that are used to measure student learning each have their own limitations and biases, and no method can be counted on to be completely error free. That is why best practice in educational research dictates triangulating the data. If several different sources of data is used, it increases the probability that the findings present an accurate picture. In other words, the strongest assessment programs will rely on a mix of direct and indirect measures[7].

Kirkpartick [42] has developed a very popular evaluation model that has been used since the late 1950s by the training community. The focus is on measuring four kinds of outcomes that should result from a highly effective training program.

Kirkpatrick's model includes four levels or steps of outcome evaluation:

1. Reaction – what they thought and felt about the training (satisfaction; "smile sheets") - Did participants like the training they received?

2. Learning – the resulting increase in knowledge and/or skills, and change in attitudes - Are participants confident that they have learned something from the training program?

[7]Indirect measures include data from surveys of seniors and alumni, retention rates, graduation rates, number of students progressing to advanced degrees, etc. They allow administrators, faculty, researchers, and consumers to infer the benefits to students from their years in college, but they cannot report with precision exactly what students have learned or what they are capable of doing as a result of their university education. Direct measures provide more evidence of the increase in students' knowledge and abilities over a period of time. Standardized tests as, for example, the Collegiate Learning Assessment (CLA) are one kind of direct measure. While the CLA assesses general education skills, other standardized tests can measure specific disciplinary knowledge. Other examples of direct measures include assignments that ask students to perform some kind of conceptual task (e.g., create a concept map) or portfolios compiled over a course of study. It is important to emphasize that these student work products need to be systematically reviewed for evidence of learning in order for them to be of most use. For example, grades, of course, can also be a measure of learning although how the grades are determined and reported can sometimes undermine their usefulness.

3. Behavior[8]– transfer of knowledge, skills, and/or attitudes from ”classroom” to the job (change in job behavior due to training program) – Are participants able to apply what they learned in the training program back on the job?

4. Results[9] – the effects on the business or environment resulting from the trainee’s performance, the final results that occurred because of attendance and participation in a training program (includes such items as monetary, efficiency, moral, etc.) – Did the training show improvement in efficiencies, productivity, profits, costs, reduced turnover?

Several authors have suggested an addition of a fifth level of evaluation. Phillips [68] has argued for the addition of a ”Return on Investment” (ROI) level – Did the training program show a positive ROI? – which is essentially about comparing the fourth level of the standard model to the overall costs of training. Phillips’ Level 5 takes the measurement of the effectiveness of training program to a higher level -– converting the benefits of the training to a monetary value, thereby demonstrating its value to the bottom line.

There are three problematic assumptions of the Kirkpatrick model: 1) the levels are not arranged in ascending order, 2) the levels are not causally linked, and 3) the levels are positively inter-correlated [4].

The only part of Kirkpatrick’s Four Levels that has failed to uphold to scrutiny over time is the first level – reaction. Rather than measuring reaction, what we are now discovering is that we should be preframing the learners by having their managers discuss the importance of attending a training process (on-ramping) and then following-up on them after they return to ensure they are using their new skills [86].

Before evaluating e-learning, Horton [30] suggests to consider a few specific reasons to evaluate e-learning: justify investments in training; make better decisions about training; hold participants accountable; demonstrate financial responsibility; improve training quality; encourage learning.

Effective Monitoring and Evaluation of Education (EMEE)

The underlying concept of EMEE is the idea of a clear arrangement of different feedback features, giving the teacher well-founded information on student behavior during the education cycle. A standard component of the LMS is access to statistics for different learning objects which, when combined with other information available, can be used for interesting statistical and analytical investigations. The key in this is the utilization of all data of informative value related to student activities, with subsequent storing of the data in a newly designed database structure. Through sophisticated mechanisms and selected data retrieval methods, student behavior can be mapped during different stages of studies — typically in semester cycles. The application of these principles in different learning management systems is specific mostly because each environment has, to a certain degree, a different data structure and has been created by using a different programming tool [43].

[8]”Performance” is often the preferred word for ”behavior” because, performance has two aspects: behavior being the means and its consequence being the end. In addition, some use the term ”transfer” in lieu of ”behavior” to identify the transfer of learning to the workplace.

[9]”Impact” is often used for ”results,” such as impact on the business unit.

2.3.2 Learning Process Management

A good e-learning process often involves a lot of activities that need to be done on both educator's and student's side. Also many activities are performed by e-learning tools and only some of them can be automatized. With such number of activities and relations between them, the complexity of learning process organization is growing and needs to be managed.

The most obvious case of a process from the university environment is a course. This course is taught repeatedly and the structure remains mainly the same. Modeling of e-learning courses with a lot of mixed e-learning class work teamwork and other activities is very useful. In case of really rich and interactive course the organization is too complex and starts to take too much of time to prepare it. At this moment the process-oriented approach can help to automate certain tasks and at the same time keep the organization complexity under control.

On the other hand, modeling of each process from scratch is time consuming, but in general courses consist of a lot of same sequences of activities (such as teamwork, assignment evaluation etc.). As process approach gives emphasis on re-usability with help of global sub-processes, it is possible to identify certain sub-processes in learning process that can be reused later – the learning patterns [61], [32].

2.3.3 Learning Process Modeling

In our times of fast-paced change, traditional approaches to designing and delivering education are too rigid and inflexible when it comes to adapting to new needs. Twenty-first century education calls for more flexible approaches and technology that succeeds in facilitating teachers and teaching practitioners on the one hand, and in satisfying increased quality demands of our students on the other hand. Considering this background, designing and delivering technology-enhanced education is becoming increasingly complex, particularly for novice designers and teachers. To put it very simply, they need to transform educational goals into executable learning designs.

In the field of architecture, Christopher Alexander was the first to capture, describe and disseminate expert design advice in the form of design patterns. Essentially, a design pattern provides a generic, reusable solution to a recurring design problem or situation. The key is to describe the solution in a way that makes the solution reusable for similar problems. The design pattern approach was then adopted in the 1990s by software engineers to describe elements of reusable object-oriented software design and software architecture. Not much later, computer science educators began to transfer the concept of design patterns to the educational domain.

Learning design (LD), also known as learning pattern or design pattern, refers to the range of activities associated with creating a learning activity[10] and crucially provides a means of describing learning activities. Learning design provides a means of representing learning activities so that they can be shared between tutors and designers. Agostinho [1] describes it as a representation of teaching and learning practice documented in some notational format so that it can serve as a model or template adaptable by a teacher to suit his/her context. Further she claims that the use of learning designs to share and model expert practice would not eliminate the need for authors to have an un-

[10] Learning activities are those tasks that students undertake to achieve a set of intended outcomes (e.g., contributing to a "for and against debate" in a discussion forum or constructing a group report in a wiki). Beetham and Sharpe [7]view learning activities in relation to the design process as a specific interaction of learner(s) with other(s) using specific tools and resources, orientated towards specific outcomes.

derstanding of contemporary learning theories and their applications. Instead, it would provide authors with a scaffold to help them design high quality learning environments without investment of excessive amounts of time[11].

There are different flavors of LDs in education, some more pedagogy focused like patterns for seminars [24] other more technology focused like patterns for designing learning management systems (LMS) [5]. In the recent past, we have witnessed a number of design pattern initiatives and projects dealing with educational LD, e.g.:

- The Pedagogical Patterns Project[12] was one of the pioneers; it produced a number of pattern collections related to various aspects of teaching and learning, e.g., patterns for seminars [24], active learning, experiential learning, feedback, etc.
- E-LEN[13] a European project providing patterns for learning resources and LMS, life-long learning, collaborative learning, and adaptive learning.
- Kaleidoscope[14] is a network of excellence, partly dealing with the provision of design patterns for games-based mathematics education.
- TELL[15] was an international project that created patterns for networked collaborative learning.
- The PCeL pattern repository [20] provides patterns for implementing technology-enhanced learning based on a person-centered educational philosophy.

Process-oriented learning designs (POLD) are used to describe innovative teaching activities (processes) that can be generalized and used across different disciplines. Marjanovic [59] uses an example of a new type of educational technology called the web-based handbook to illustrate multi-level modeling of POLD that is at the core of design and implementation of this new technology.

Process-oriented learning designs (POLD) are used to describe innovative teaching activities (experience) that share the following characteristics: (i) they can be described as a set of coordinated learning tasks performed by students, their teachers or, in some cases, by computers; (ii) they can be generalized from the context of one discipline and then reused across disciplines and (iii) they can be used both in e-learning and combined (blended) learning. An example is a problem-solving process that is at the core of problem-based learning.

One of the main drawbacks of existing educational LD approaches is the missing support for pattern users; there is a lack of tools and integration into existing learning management systems. The reason is that most projects terminate their efforts right after the production and dissemination of patterns and focus on reusing design, but not on actual tools supporting the implementation of patterns, which is an essential aspect for promoting the use of educational design patterns among educators [21].

[11]For example, the LD might consist of illustrating learning activities in an easy to understand way (as a diagram and/or text) so that they can be (i) shared between a teacher and a designer, (ii) repurposed from one teacher to another, (iii) serve as a means of scaffolding the process of creating new learning activities, or (iv) provide the tools for practitioners to capture their innovative practice in a form that is easy to share so that they have ownership of the problem and solution. Such a scaffold might be in the form of an online tool to provide support and guidance to a teacher in the steps involved in creating a new learning activity, including tips and hints on how they might use particular tools.

[12]`http://www.pedagogicalpatterns.org` (2002)

[13]`http://www.tisip.no/E-LEN/` (2003)

[14]`http://lp.noe-kaleidoscope.org`

[15]`http://cosy.ted.unipi.gr/tell/`

In technology-enhanced educational design, the selection and configuration of tools and services is a potentially complex task. This is where previous educational design pattern approaches have failed to provide adequate support for their pattern users. That's why Derntl and Calvo [21] proposed a framework-based approach to providing and integrating educational design patterns into existing LMS.

Learning Design Representation

The need for e-learning systems that support a diverse set of pedagogical requirements has been identified as an important issue in technology-enhanced education. As a response to pedagogical concerns towards standardization and interoperability need, IMS LD specification was introduced. Nevertheless, despite the wide adoption of the IMS LD still a common language for graphically representing learning flows is missing. This is due to the fact that although the IMS LD provides the means for technically representing learning flows (sequences of activities), it doesn't provide guidance on how these flows could be represented in a human understandable way. As a result, there exist several authoring tools for designing learning activities that export content packages conformable with IMS LD, but these tools are using different representations of the learning process.

On the other hand, there exist standards for creating human understandable graphical representation of processes (such as BPMN standard), that could be useful in providing common representations of learning flows.

Goodyear [27] concludes that the current ways of representing and sharing educational designs need improvement and argues for a mechanism to capture design knowledge in a way that bridges the gap between research-based evidence of pedagogical theory and practical application of that theory. Similarly, Waters and Gibbons [85] state that a notation system for educational design, similar to that found in other disciplines, such as music and dance, is needed to provide a common language that will allow better communication of ideas, and in turn could serve as a stimulus to improve the quality of teaching and learning.

Over the last ten years, the concept of learning designs has evolved as a strategy towards a common language to serve as an accessible and usable form of guidance for university teachers [52]. Learning design can be considered as either a process of designing learning experience [16] or a documented outcome of the design process [2].

Several learning design representations have emerged over the last decade and those featured in recent research work according to Agostinho [3] include:

- E^2ML – Educational Environment Modeling Language - represents a LD as a structured set of activities aimed towards achieving a set of defined learning outcomes. It was developed to enhance communication within e-learning project teams.

- IMS Learning Design (IMS LD) – represents a learning design as a sequence of activities described in the form of acts in a play (referred to as a unit of learning). It is documented in a computer readable format (XML file) and its purpose is to offer technical interoperability.

- LAMS – Learning Activity Management System – is a software application that allows a teacher to both design, share and implement online learning activities using a visual authoring environment. The learning design is visually represented in a flow-chart as a sequence of activities, which are represented in the form of the online tools used to run each activity

- LDVS – Learning Design Visual Sequence 0- documents a LD in a visual way by illustrating the chronology of tasks, resources and supports using symbols for each of the three LD elements (task, resources and supports). A time period for the LD and intended learning outcomes are also included.

- LDLite – documents a LD in a tabular form and is based in five key elements of IMS LD: tutor roles, student roles, content resources, service resources and assessment/feedback. It is used to help teachers design blended activities, that is, integrate face to face and online activities.

Each of these LD representations document a LD in a different way and it can serve different purposes. For example, the purpose of EML and IMS LD is to document a contextualized LD, this they provide specificity and logistical detail of a LD.

IMS Learning Design (IMS LD) is today's most popular educational modeling language to describe technology supported pedagogical scenarios based on rich instructional design models. It is based on Koper's Educational Modeling Language (EML) informally published in the early 1990s. Several systems with educational design languages[16] can produce IMS LD output. Others either don't necessarily rely on a formal language or adopt another formal representation.

Most current educational design languages adopt some kind of "activity flow" approach. Designs for educational sequences then can be defined with several notations, for example:

- Some kind of visual flow chart (e.g., a UML activity diagram or similar), e.g., the formal coUML design language.

- Logical descriptions with a specialized concept mapping language, e.g., the formal MOTPlus editor for IMS LD or the informal CompendiumLD editor.

- Forms-based editors where sub-activities are described as lists (e.g., the ReCourse editor for IMS LD

- Sequences of tools use, i.e., activities are described by configuring how the tool should be used at some point), e.g., LAMS or CoFFEE.

Learning Design Execution

A learning design defines a flow of activities where students and teachers play roles while using tools and services with the aim of accomplishing their learning goals. Through a learning design, different actors do not have to be concerned much about the management of learning flow and data flow within a course: this should be performed automatically by the learning management system (LMS) [44].

The analysis of the similarities between collaborative learning processes and business collaborative processes suggest that following the example of the business industry could be a path to follow. If we consider the success of work flow management systems when applied to business processes, it seems natural to consider that using those very systems to execute learning processes should yield beneficial results [67].

[16] An educational design language is a notation system for creating educational designs, e.g., courses, modules, or scenarios. An educational design language is a tool that designers use to communicate designs, plans, and intentions to each other and to the users of their artifacts

It is also interesting to note that only a few implementations of Learning Design currently exist[17] and they don't usually support the standard further than Level A, although CopperCore is the exception and supports Level C[18]. The use of existing work flow solutions like middleware will enable the support Level C with a more reasonable amount of effort when compared to the complexity of developing an entire engine from scratch and will also provide additional benefits implicit in work flow systems [67].

2.3.4 Project Medusy

Project MEDUSY (Multi-Purpose EDUcation SYstem)[19] is focused on development of rich e-learning environment that will enable wide integration of various e-learning tools. Project tries to leverage some of the e-learning best practices used in modern LMSs and introduce process-oriented approach to course development and education flow in general.

At the moment project is in early phases of development such as analysis and design. We have done one functional prototype of process based e-learning application and now we are in next iteration where we try to integrate more widely used services into the project. Project is developed within industry partnership between Red Hat and Masaryk University (LaSArIS lab).

MEDUSY aims to be modular and will allow plugging in traditional content-based LMS as well as other widely web-services used in e-learning context. Other aim of this project is to provide better control over e-learning multimedia content. It should also allow management of systems and installed applications used for hands on trainings in technical courses. Last but not least MEDUSY should also provide infrastructure for management and monitoring of learning processes that will help to improve their quality and effectiveness.

In our perception the educational pattern is a small reusable sequence of steps that are included in one blended learning activity. Patterns should be used as building blocks for more complex blended courses [5]. A pattern should define general structure of the activity and should be customizable. One of our aims is to build community based repository of such patterns. Patterns should be built on best practices in blended courses and each pattern should define "standard" structure of activity that can be extended according to specific needs of other (re-)users. In context of learning activities it should serve as a guideline, how to use certain educational pattern.

[17] CopperCore Project: `http://www.coppercore.org`

[18] According to the CETIS Briefing on Learning Design `http://www.cetis.ac.uk/lib/media/WhatIsLD_web.pdf`: Level A contains the core of IMS Learning Design: people, activities and resources, and their coordination through the method, play, act and role-parts elements. This simply provides for a series of time ordered learning activities to be performed by learners and teachers, using learning objects and/or services. Level B adds greater control and complexity through the use of properties and conditions. Properties may be internal (local) or external (global). They are used to store information about a person, such as test results or learner preferences; a role, such as whether the role is for a full-time or part-time learner; or a learning design itself. Internal properties persist only during a single run of a learning design, while external properties retain their values beyond the end of a run, and can be accessed from different runs and/or different learning designs. Level C offers the opportunity for more sophisticated learning designs through notifications (messaging), which allow for notification of new activities to be triggered automatically in response to events in the learning process. It enables the automation of learning flow activities, which are triggered by the completion of tasks, rather than the learning flows being pre-planned. For instance, a teacher may be notified by email that an assignment has been submitted and needs marking; once the score has been posted, the learner may be notified to undertake a new activity according to the result.

[19] `http://sourceforge.net/apps/mediawiki/medusy/index.php?title=Main_Page`

Modeling of processes from scratch demands a lot of not only time resources. That's why we have to carefully consider the appropriate level of granularity and build reusable patterns. With growing complexity of a pattern, we decrease its flexibility. Inflexible patterns can limit us during building the whole course process. On the other hand, too fine-grained patterns increase the effort required to model the course. Therefore, a rational decision on the pattern granularity is crucial.

We also have to carefully consider roles in our pattern and we have to make sure they can be mapped to roles in other learning process where we want to reuse our pattern. Every pattern description should consist of [32]:

- Pattern purpose and goal we want to achieve
- Roles involved in pattern
- List of activities performed within the pattern
- Data objects use in a pattern
- Inputs and outputs
- Communication with parent process
- Process model of the pattern (preferably Business Process Modeling Notation (BPMN)[20]

We decided to model processes in BPMN 2.0, because the modeling language has to be capable of immediate execution after modeling. That's why BPMN 1.1 in combination with BPEL[21] is not an option.

One of the main advantages of process approach is the possibility of continuous improvement of the processes. For this purpose we can use recorded monitoring data and evaluate the process efficiency. Consequently we can use them for improvement of process in next iteration of the process[22].

It is recommended to revise monitoring data each time the course is completed and analyze them for further process improvement.

Monitoring is always important but it particularly makes sense in case when more participants are involved. For efficient monitoring of the process we have to consider monitoring already in phase of process modeling.

There are several teams and projects, that are focused on process-oriented approach to learning processes, learning designs and patters. I would like describe two most important and inspiring for MEDUSY project.

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[20]The Business Process Modeling Notation (BPMN) standard provides the means for creating human understandable graphical representations of processes (work flows). Thus, it can be used for defining graphical representations of educational processes (learning flows) modeled with the IMS LD specification).

[21]Business Process Execution Language (BPEL) is an XML based language that represents work flows, and is directly mapped to BPMN graphical design elements. There are two basic structures of a BPEL document. BPEL format can be based on the BPEL graph structure (the flow element) or the BPEL block structure (the sequence element). The main advantage of the mapping of BPMN to BPEL's graph structure is that the result of the mapping defines a directed graph that can be transformed to the IMS LD notation language. Such and approach bared the potential to improve interoperability between high level IMS LD tools. Karampiperis and Sampson [38] proposed algorithm for transforming BPEL work flows to IMS LD level A learning flows.

[22]In our common case where process represents a course, one iteration is usually equal to one term (from beginning till the end of the course).

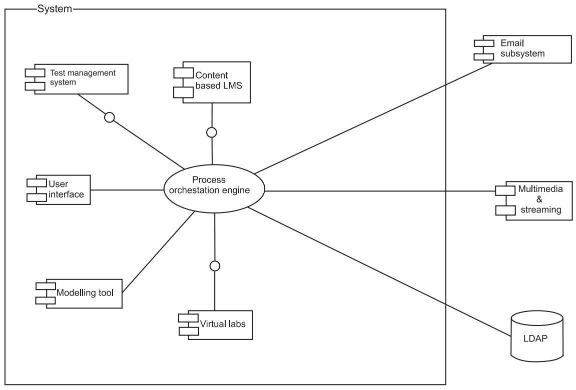

Figure 2.1: MEDUSY architecture

ICOPER – Interoperable Content for Performance in a Competency-driven Society

ICOPER[23] is a Best Practice Network co-funded by the eContentplus programme of the European Community. The 30-months-project started in September 2008 and ended in February 2011. The mission was to collect and further develop best practices for higher education tackling issues like creating learning designs and teaching methods, authoring content for re-use, transferring knowledge in an outcome-oriented way and assessing it, or evaluating learning activities.

The ICOPER Reference Model (IRM) provides a common frame of reference for stakeholders who wish to contribute to the design and development of outcome-oriented teaching and content for re-use. Driven by this objective the IRM is designed to improve interoperability of technology-enhanced LMS and applications both at the processes level, as well as at the technical level (i.e., data and services).

They lean on UML class diagrams as modeling grammar, which represents a pragmatic combination of conceptual and formal modeling methods. They intent to develop number of applications, that will support their goal, such as[24]:

- OpenGLM – allows users to develop a new instructional model (learning design or teaching method) or to reuse an existing instructional model, for example one retrieved from the OICS.
- CLIX ICOPER – was built to facilitate a outcome-oriented learning as well as the storage, updating and publication of a learner's Personal Achieved Learning Outcomes (PALO) in the LMS/VLE CLIX ICOPER itself as well as in the Open ICOPER Content Space (OICS) and further internet platforms (e.g., iGoogle) to show learners' latest Learning Outcomes to his/her fellow students and/or potential employers.
- Moodle-OICS Interface – will import the LD into an existing course or to a new course in Moodle.
- OICS Recommender that will give recommendation of other teachers with similar learning outcomes to the teacher logged in.

[23] `http://icoper.org/`
[24] `http://www.icoper.org/results/deliverables/D7-3b`

- 2know2.com – this prototype allows teachers and course designers to announce learning opportunities that are linked to learning outcomes and teaching methods. The learning outcomes and teaching methods are directly stored in and retrieved from the OICS via the search, retrieval and publishing services of the OICS Middle Layer. New learning opportunities can be announced at the `2know2.com` platform with a news article and an RSS feed and can also be published in the repository for learning opportunities at the OICS

Prolix – Process-Oriented Learning Requirements

PROLIX[25] is a 48 months research and development integrated project co-funded by the European Commission. It started on 1st December 2005 so it's over now.

The objective of PROLIX was to align learning with business processes in order to enable organisations to faster improve the competencies of their employees according to continuous changes of business requirements. To reach this goal, PROLIX developed an open, integrated reference architecture.

The objectives of PROLIX were to research, analyze and develop a process-oriented learning approach and a flexible and adaptive service-oriented architecture system which is capable of aligning training and knowledge product ion of people faced with so-called "complex situations" such as work and business process changes, or other complex multivariable learning environments, which cannot be solved with traditional e-learning or knowledge management approaches. Often, such situations also require a mix of individual and organizational learning, and of learning and knowledge acquisition/production.

One of the core objectives of PROLIX was to deliver an open reference architecture for process-oriented learning and information exchange, integrating Competency Management, Learning Management, Business Management, and Performance Monitoring applications. They achieved the goal of creating such an architecture, however they were not able to foster its usage outside of the PROLIX system.

They achieved to develop also other components:

- Repository of Didactical Learning Models - repository of learning design templates represents ready-to-use didactic models that can be used when designing a course and that are compliant to the IMS Learning Design specification. The collection comprises 54 templates that are stored in the repository along with a small set of Learning Object Metadata (LOM) descriptors relevant for easy search and browse discovery. The learning design templates have to be joined with specific learning materials and learning objects to create a complete course. When relying on learning design templates, the instructional designer is put in position to create didactically sound courses, because the templates are each grounded in a theoretical foundation or practical experience.

- Learning Process Configurator (LPC) is a professional application that allows user to search and retrieve learning material as well as create reusable learning courses in answer to the identified needed competencies. The LPC implements levels A, B and C of the IMS-LD.

- Learning Process Execution Platform (LPEP) is the learning management system (LMS) of the PROLIX software suite. It has been developed based on requirements from test beds and module partners

[25] `http://www.prolixproject.org/`

Chapter 3

Research Proposal

This chapter explains the research focus, restriction of the scope on sub-domain of reasonable size and research question which we want to answer. Further, we would like to refine the research focus in more goal-oriented way and specify exact goals of the research and time plan for achieving them. Small changes in the Plan can occur according to new findings discovered during the research, but general structure of the plan should remain the same.

3.1 Scope Restriction

We restrict the scope of the research on a sub-domain of knowledge management, because the domain of knowledge management itself is rich and many aspects differ significantly according to type of knowledge being transferred.

Knowledge Management Sub-domain

The studies in the field of KM have largely focused on three major streams [26]: the nature of knowledge; the processes of KM such as generation, sharing, distribution of knowledge; and the infrastructure of KM such as technological, organizational or managerial issues for managing knowledge effectively.

As we mentioned in the Chapter 1, we want to primary focus on the sub-domain of KM which involves the processes of KM, such as learning processes and education in the organization, which means the generation, sharing and distribution of knowledge.

Side focus of the research is on technological issues for managing knowledge effectively.

Type of Knowledge Scope

Different frameworks exist for distinguishing between different 'types of' knowledge. One proposed framework for categorizing the dimensions of knowledge distinguishes between tacit knowledge and explicit knowledge. Tacit knowledge represents internalized knowledge that an individual may not be consciously aware of, such as how he or she accomplishes particular tasks. At the opposite end of the spectrum, explicit knowledge represents knowledge that the individual holds consciously in mental focus, in a form that can be easily communicated to others [8].

We want to focus mainly on transfer of explicit knowledge, learning processes of hard skills, especially in technically oriented context. This transfer of knowledge can be easily supported by learning processes with hard-set structure and e-learning as a tool of knowledge management.

Paradigm of Knowledge Management

Knowledge management subtopics can be grouped in terms of discipline or education as four paradigms [75]: organizational, humanist, socio-technical and technological.

In this research, we want to focus mainly on the Technological paradigm that is based on the important assumptions related to technological advancements which have crucial role concerning providing, sharing and disseminating 'structured information' in the system.

3.2 Isolation of Research Question

To identify accurately the research question, we have to highlight several problems mentioned in the introductory chapter and define a subset where we are able to perform the research in depth and give a valuable complete answer.

The effective use of technologies creates new ways of knowledge transfer and holds promising solutions both in transfer of explicit knowledge and tacit knowledge [34]. In this respect, technologies have a strategic importance not only in knowledge transfer inside the organization but also knowledge transfer among different organizations [89]. Managing knowledge efficiently and effectively is considered a core competence for organizations to survive in the long run. The capability of organizations to leverage their knowledge resources seems to be one of the most important parameters from the strategic perspective [88].

We can say that knowledge efficient organization is such organization that effectively manages its knowledge, i.e., in our scope restriction such organization has implemented effective and efficient learning processes.

Therefore we reduce these mentioned problems to address the following research question: How to achieve the transformation to knowledge efficient organization?

We further decompose this question to three separate sub-problems:

1. How to achieve efficient knowledge transfer among participants of the learning process?
2. How to define, execute, manage and measure such process?
3. How to leverage modern e-learning technologies in such process?

3.3 Expected Results of the Research

Answering the research question and each of the sub-problems should lead to following research results:

1. Methodology for the whole life-cycle of identification, definition, execution and efficiency measurement of the learning process inside organization.
2. Generic management system architecture which will support such life-cycle.
3. Functional prototype implementation of such management system and verification in production environment.

The methodology will cover in detail iterative life-cycle of the learning processes inside organization. It should provide guidelines for assessment of KM maturity inside the organization; analysis and identification of key knowledge areas; learning processes and their improvement and refinement; and finally execution, management and consequent monitoring, measurement and evaluation of learning processes.

Key elements described by the methodology will be:

1. KM areas/subareas and their importance for the organization.
2. Roles in the organization and their relationship to KM areas
3. Current/New Learning processes (and their relationship to KM areas and roles)
4. E-learning and other supportive systems and tools used in processes
5. Information sources, internal and external subjects involved in processes

The generic management system architecture will describe architecture of desired IT solution used for design, execution and consequent efficiency measurement of learning processes and hierarchy of services to be provided. Such management system will provide interface for:

1. Definition and management of elements defined in the methodology
2. Control over the e-learning multimedia content
3. Learning process management and monitoring
4. Plugging in traditional content-based learning management systems (LMS)

The functional prototype can be verified at Faculty of Informatics at Masaryk university or other universities, or at business partners of the faculty.

3.4 Impacts of Use

There are desired outcomes of the methodology, which need to be evaluated to measure the success of knowledge transfer and provide feedback for later methodology enhancement.

Primary outcomes of the learning process methodology adoption are:

1. Assesment of organization's KM areas and learning potential in each of them. It's value and linkage to organization's strategy and vision.
2. Identification and improvement of information flow structure and knowledge sharing in organization.
3. Identification and optimization of organization's learning processes.
4. Documentation of learning processes that will make them clear and visible to all the participants.
5. Establishment of learning process monitoring and evaluation of its performance.
6. Improvement of training, development and also organization's performance.

Secondary outcomes of such adoption should be:

1. Systematic building of codified learning process know-how, valuable for organization's growth

2. More accurate estimation of knowledge management (respectively the learning process) costs

Such outcomes and impacts of knowledge management and learning processes in organization are described for example in [10].

3.5 Evaluation of Research Results

An evaluation of the proposed research is not a trivial problem. As it was stated in the Chapter 2, the measurement of KM efficiency in the organizations is in general done in two main ways; by "log in database" or by conducting "surveys". Therefore, we suggest the empirical evaluation of proposed methodology and system.

Because of applied research, we set as the key evaluation criterion the applicability of my research in industry, the satisfaction of subjects who successfully leverage the process-oriented approach in KM.

If the organization adopts the methodology of process-oriented KM (i.e., learning processes) successfully, the growth of educational quality will be achieved and the output of learning process measurement will bear a value for a management, it shall be considered as successfully adopted and the research as valuable.

We will obtain the feedback by interviewing stakeholders involved in the case study and capturing observed improvements for each aspect mentioned in the section 3.4. From the collected data, we will evaluate each of the listed aspects and identify weak points.

Interviews with participants of the learning process will provide feedback on knowledge transfer and learning process; interviewing managers will provide feedback on learning process monitoring and evaluation of its performance and documentation of learning processes.

Another kind of continuous evaluation of the work will be a regular background research of existing and newly introduced methods, techniques and frameworks with similar or the same focus in both commercial and scientific contexts.

We expect most of the subjects of case studies and following evaluation of proposed research to be the one of Faculty industry partners and partners of iCom project.

3.6 Goals

Goal 1 Deliver detailed methodology for end-to-end implementation of MEDUSY project for learning processes in organizational knowledge management. Key elements of the methodology are described in section Expected results of research.

Goal 2 Develop architectural concept of MEDUSY that will be used for modeling, execution and consequent evaluation of learning processes.

Goal 3 Develop supporting SW tool for definition and management of the key elements defined in the methodology.

Goal 4 Elaborate case studies applying the elaborated methodology in real projects from commercial and academic environment.

Goal 5 Evaluate the organizational knowledge improvement.

3.7 Current Results

In my previous work, I have focused on effective monitoring and evaluation of education. Well-founded feedback called EMEE (Effective Monitoring and Evaluation of Education) represents an interdisciplinary project combining an informatics approach with mathematical and pedagogical methods. The EMEE idea is based on an innovative feedback method integrated into an appropriate learning management system. The added value lies in new information for teachers discovered by data mining, statistical and analytical data processing. The results will be clearly visualized in diagrammatic form (graphs and tables). EMEE functionalities will be available in the most widespread and most popular LMS Moodle. All fundamental principles including the conceptual database model are described in [43].

As a member of a team working on the FRVŠ project no. 1035/2011/G6, Improvement of practical process management education, I have also dealt with identification and software support of processes in the field of crisis management. We also proposed a Process Framework for Emergency Management which can describe precisely the process deployment in the area of emergency management taking into account its process oriented methodology and complex architecture. The correctness of the Process Framework is guaranteed by continuous verification, validation and optimization of emergency processes. Applicability of the solution was shown on a case study that simulates progress of an emergency situation in the real environment [55], [54]. These papers have been presented at 25th EUROPEAN Conference on Modelling and Simulation (ECMS 2011) in Poland and 1st International Conference on Simulation and Modeling Methodologies, Technologies and Applications (SIMULTECH 2011) in Netherlands.

3.8 Time Plan

Spring 2012

In the next semester, it is necessary to outline the methodology definition and functional specification of supporting SW tool. Also we need to outline the evaluation criteria for knowledge improvement measurement.

Autumn 2012

Next step includes elaboration on detailed methodology (specification of roles, activities, artifacts) and we also need to refine the functional specification of the SW tool. Meanwhile the first prototype of the generic management system will be designed.

We expect that evaluation criteria for measurement of knowledge improvement will be published on the 21st ACM International Conference on Information and Knowledge Management (CIKM 2012) or on 6th World Summit on the Knowledge Society (WSKS 2013).

Spring 2013 – Autumn 2013

Implementation of the SW tool will be in progress and elaborate a case study (at least one in academic and one in commercial environment) to verify the methodology. After evaluation of case-studies, we can also evaluate the knowledge improvements in organization due to evaluation criteria.

Also after the evaluation of case-studies we can finish the methodology and integrate all findings. After that we are ready to apply this methodology to a complex project from commercial or academic environment.

We expect that Learning Process Methodology implementation will be published on 22st ACM International Conference on Information and Knowledge Management (CIKM 2013).

Thesis should be done by the end of 2013.

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Appendix A

Study Results Summary

Selected Publications

- Ludík, T., Ráček, J., Pekárková, L. *Methodology and Recommendations for Crisis Processes.* Proceedings of 1st International Conference on Simulation and Modeling Methodologies, Technologies and Applications. Portugal: SciTePress, 2011. p. 333–338. (**Scopus indexed**)
- Komenda, M., Pekárková, L., Schwarz, D. *EMEE -– Well-founded feedback in learning management systems.* In Sborník příspěvků Mezinárodní Masarykovy konference pro doktorandy a mladé vědecké pracovníky 2011. 2. vyd. Hradec Králové: MAGNANIMITAS, 2011.
- Komenda, M., Pekárková, L. *Integrace EMEE do systémů pro řízení výuky.* In 8.letní škola aplikované informatiky. Brno : MSD, spol.s.r.o., 2011. p. 99–106.
- Ludík, T., Ráček, J., Pekárková, L. *New Process Management for Emergency Management: Case Study about an Accident of a Vehicle Transporting Dangerous Goods.* In Proceedings of 25th European Conference on Modelling and Simulation. Krakow: European Council for Modelling and Simulation, 2011. 7 p.
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- Hřebíček, J., Pekárková, L. *Key performance indicators for sustainable reporting according to NACE.* In EnviroInfo 2008. 22. International Conference on Informatics

fo Environmental Protection. Environmental Informatics and Industry Ecology. Aachen: Shaker Verlag, 2008. p. 45–53.

Posters

- Pekárková, L. *Process-based E-learning and Knowledge Management.* The 4th Practice-Research Workshop in Palais Festetics, Vienna, Austria. 2011.

Projects with my Contribution

- FRVŠ project no. 1035/2011/G6, Improvement of practical process management education.

  Project was aimed to support creative activities of researchers to expand the education in subjects Process Management (PV165) and System Analysis and Design (PB007) by the area focused on process analysis and design in the crisis management, their subsequent simulation and optimization with the objective of an overall process automation.

- iCom

  Since January 2011, the University of Vienna (Austria) and the Masaryk University in Brno (Czech Republic) are working together in an EU-funded project to build up an additional course offer in the doctorate studies "Computer Science" and "Business Informatics" with a focus on "International Constructive Communication in the Context of ICT".

Appendix B

Attached Publications

- Ludík, T., Ráček, J., Pekárková, L. *Methodology and Recommendations for Crisis Processes.* Proceedings of 1st International Conference on Simulation and Modeling Methodologies, Technologies and Applications. Portugal: SciTePress, 2011. p. 333–338. (**Scopus indexed**)
- Komenda, M., Pekárková, L., Schwarz, D. *EMEE -– Well-founded feedback in learning management systems.* In Sborník příspěvků Mezinárodní Masarykovy konference pro doktorandy a mladé vědecké pracovníky 2011. 2. vyd. Hradec Králové: MAGNANIMITAS, 2011.
- Komenda, M., Pekárková, L. *Integrace EMEE do systémů pro řízení výuky.* In 8.letní škola aplikované informatiky. Brno : MSD, spol.s.r.o., 2011. p. 99–106.
- Ludík, T., Ráček, J., Pekárková, L. *New Process Management for Emergency Management: Case Study about an Accident of a Vehicle Transporting Dangerous Goods.* In Proceedings of 25th European Conference on Modelling and Simulation. Krakow: European Council for Modelling and Simulation, 2011. 7 p.

METHODOLOGY AND RECOMMENDATIONS FOR CRISIS PROCESSES

An Effective Way How to Manage Business Process Deployment in the Crisis Management

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Keywords: Process Management, Crisis Management, Process Oriented Methodology, Recommendations, Case Study, Business Process Management Suite.

Abstract: The paper focuses on identification and software support processes in the field of crisis management. The paper aims to describe a process methodology for crisis management. The methodology consists of five main phases, being Identifying, Modelling, Configuration, Execution/Monitoring and Optimization of processes. Each phase is described in terms of individual activities, input and output artefacts, and user roles. The next part of the paper recommends the use of particular technologies, tools and resources that have been successfully proved in the analysis of crisis situations in the Czech Republic. Established process methodology and practical recommendations create the foundation for the full methodology deployment in practice. Throughout this paper the emphasis is on practical demonstration of results on a case study that applies a process methodology and hereof related recommendations in the crisis situation.

1 INTRODUCTION

The crisis management requires considerable effort. To manage crisis situations, it is necessary to spend human resources and technical resources. It is useful if there are available some best practices in solving the crisis and also specified responsibilities for particular activities. To capture such information it is appropriate to use the process management, which has been approved in the private and public sector (Kubíček et al., 2010).

Identification and subsequent automation of the process is a challenging issue. At present, there are primarily two different approaches to the business process deployment. One is based on the business process life-cycle, the second one on the overall architecture which supports the business process deployment. It is convenient to integrate the mentioned approaches to the process management for effective process deployment and create an unified view of the process deployment. Such a view is defined by Process Framework for Crisis Management (Ludík and Ráček, 2011).

The Process Framework for Crisis Management provides a basic view of the process deployment from the methodology and architecture point of view. For this reason, this paper aims to describe the process-oriented methodology, which is an essential part of the framework. The paper also contains a case study that illustrates the use of process-oriented methodology in practise and its adequate support by Business Process Management Suite.

There are many methodologies that lead the user through the process deployment, e.g. *Object Process Methodology*, *Rational Unified Process* or *Business Driven Development*. The business process analysis is the principle of these methodologies, but the process automation does not follow the process management ideology.

1.1 Object Process Methodology

Object Process Methodology (OPM) (Dori, 2000) is an approach to design information system by representing it by *object models* and *process models*. OPM combines a minimal set of building blocks with a dual graphic-textual representation in a single diagram type.

The disadvantage is the non-standard diagram notation, which has similar properties to the Data

Flow Diagram. Another disadvantage is a low correlation between modelled process diagrams and their subsequent implementation.

1.2 Rational Unified Process

The Rational Unified Process (RUP) (Shuja and Krebs, 2008) is an iterative software development process framework created by IBM in 2003. RUP is not a single concrete prescriptive process, but rather an adaptable process framework, intended to be tailored by the development organizations and software project teams that will select the process elements that are appropriate for their needs.

The disadvantage of RUP methodology is that business process analysis is used only at the beginning in order to create business requirements. The final application reflects the business processes, but there is not created a closer bond with them. Therefore, even a small change of business process leads to a fundamental change of the created information system.

1.3 Business Driven Development

Services-Oriented Architecture (SOA) provides an IT framework along with a set of principles and guidelines to create IT solutions as a set of reusable, and configurable services that are independent of applications and runtime platforms. Transitioning an enterprise to SOA requires a Business Driven Development (BDD) approach that uses business goals and requirements to drive downstream design, development, and testing (Mitra, 2005).

It is the best of so far described methodologies from the view of the close interdependence to business processes. But there is missing the application of a workflow reference model that allows to deploy the modelled process instance directly to the workflow engine.

2 PROCESS ORIENTED METHODOLOGY

The created process-oriented methodology is based on the above mentioned methodologies but also eliminates their disadvantages. This innovative methodology is described in terms of different phases, from which it is composed, as well as in terms of user roles and work products generated by this methodology.

2.1 Phases

The first phase of the methodology is *Identifying* (Figure 1). In this phase the strategic objectives of the organization are defined. In accordance with them there are also identified processes that bring added value to the organization. These processes can be divided into *primary*, *support* and *management* processes (Fiala and Ministr, 2007). It is also appropriate to assign responsibility for individual processes and particular activities as well. It is appropriate to use the Use Case Diagram to integrate processes and user roles. The output of the phase is a list of business requirements. It is convenient to define the Glossary to better understand the area of interest, which facilitates communication between user roles. The last tasks of the phase are verification and validation of business requirements.

In the *Modelling phase*, the business process is modelled in detail and decomposed into several levels, depending on its complexity (Weske, 2007). During this phase the emphasis is on the correct data flow in processes. Decision-making in processes is solved by using business rules, which could be changed during the process runtime. Designed processes should be simulated in this phase. Simulation can reveal bottlenecks in the process and also visualize the process functions. The outcome of this phase is the system requirements determination. System requirements should be verified and approved by the user-validation. Key outcome is the appropriate automation level determination.

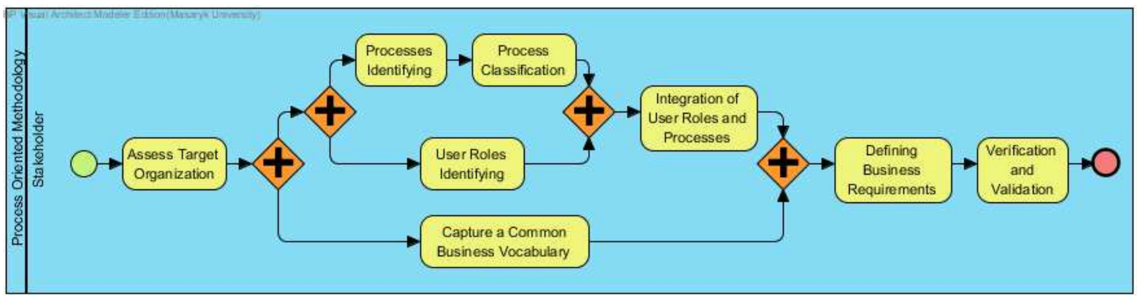

Figure 1: Identifying phase of Process Oriented Methodology.

The Configuration phase deals with detailed set up of business processes. Processes are transformed into the configuration phase mostly in Business Process Execution Language (BPEL). In this form they are accompanied by the necessary functionality build on service-oriented architecture. Processes consist of already existing services or of the brand new ones that need to be programmed. In this phase are created the key performance indicators (KPI) that are intended for the process performance control during the runtime. In such way the comprehensive application is built on business process. Its instances can be deployed on the workflow engine. The created system is set to the end customer. The service and process testing, as well as system validation, belong to the control mechanisms.

The Execution/Monitoring phase provides primarily two activities. First it is an administration of running process instances in the workflow engine, which allows the end users to work with the processes. Created applications can be set up and configured during the runtime. Business rules enable the configuration of the branching in processes, which enables better response to possible changes in a company. Setting of the user rights and roles is another option. Roles and rights can be assigned or removed for the current or new users, according to their current responsibilities. This phase is also responsible for process monitoring and for gathering data about the process run. Based on this information, it is possible to evaluate the process progress and partly adapt the process on the flow. Defined KPIs have a great impact. They enable overall control of the process and therefore also a rapid response to sudden changes.

The last phase is *Optimization*. This phase is crucial for continuous process improvement. During the monitoring phase the data about process instances are collected, which may result in some gaps in the modelled process. There are some advanced techniques of mathematical statistics or process mining available for the process instances analysis. Based on the results it is possible to choose two different approaches to process improvement. It is a Business Process Reengineering (BPR) or a Total Quality Management (TQM) (Řepa, 2007). TQM is focused on the consequent improvement of processes, BPR focuses on radical changes.

2.2 Roles

Stakeholder represents interest groups whose needs must be satisfied by the project. It is a role that may be played by anyone who is (or potentially will be) materially affected by the project outcome.

Business analyst is a high-level role responsible for the business analysis and BPM work activities. The business analyst performs process modelling and creates functional specifications for process.

Architect is a high-level role responsible for the overall work effort of creating the architecture and system design. More specialized roles, such as enterprise architect, application architect, SOA architect, and infrastructure architect, are actually responsible for various architectural work efforts that constitute the design phase of the project.

Developer is a high-level role responsible for the implementation of the result (services).

Tester is a role responsible for performing activities required to test the application before it is deployed into a production environment.

Line Manager is a person who heads revenue generating departments (manufacturing and selling) and is responsible for achieving the organization's main objectives by executing functions such as policy making, target setting or decision making.

2.3 Work Products

This section describes the outputs generated by the methodology. Thus outputs are quite a bit through the methodology phases and therefore only main outcomes of the various phases are described.

Business Requirements are based on customer's wishes and their needs. They describe the principles and functioning of a company as a whole, defining its objectives (Shuja and Krebs, 2008). Identified processes are part of these requirements.

System Requirements are the modelling phase results. These are the requirements for creating an information system built on business processes. Detailed and hierarchically organized process diagrams are part of this output. These requirements also describe the level of process automation.

Information System is a result of the configuration phase. Modelled processes are configured and composed of individual services. Thus created processes are deployed on a process engine, which interprets them. The workflow engine also allows interaction with users and external tools.

Monitoring data is an output of the monitoring phase. It contains information about process instances run, such as duration or cost of individual processes. It also records the passing through the business process, which can be useful in further analysis.

Strategic plans are the optimization phase outputs. The overall technology improvement (TQM, BPR) and strategic plans for further business process improvement are chosen in strategic plans.

3 RECOMMENDATIONS FOR CRISIS MANAGEMENT

In case the methodology is used in the field of crisis management it is appropriate to consider certain features that arise from this specific area. This features are illustrated on crisis management in the Czech Republic.

3.1 Organizational Structure

The Integrated Rescue System (IRS) is determined for co-ordination of rescue and clean-up operations in case, where a situation requires operation of forces and means of several bodies, e.g. fire fighters, police, medical rescue service and other bodies, or in case, where the rescue and clean-up operation is necessary to be co-ordinated from the Ministry of Interior or by a leader of region's level, or by mayors of municipalities with extended responsibilities (Rektořík, 2004). As the Integrated Rescue System are therefore considered the co-ordinated proceedings of its bodies during preparations for crisis situations, and during rescue and clean-up operations.

3.2 Legislation and Documentation

There are many laws dealing with crisis management in the Czech Republic. Crisis management elements are codified in the Law No. 240/2000 on crisis management and on modification of certain codes (Crisis Code), in latter wording. The other important Law is the Law No. 239/2000 on the Integrated Rescue System and on amendment of certain codes, in latter wording. It is the basic legal frame describing situation around IRS.

Another feature of the crisis management is the detailed documentation that defines how to proceed in particular situations. The Contingency Plans belong to the basic documents. They contain a set of measures and procedures addressed to crisis situations.

3.3 Different Types of Information

To successfully deal with critical situations, it is inevitable to have all the necessary information at disposal. It is often not trivial because the information used in crisis management can have three basic characteristics or dimensions: *time*, *space* and *aggregation*. The time dimension of the data is important in the crisis situation with dynamic character. This information varies with time so it is a relevant factor in dealing with the crisis situation. Another important aspect of the information is that it is bound to the intervention place. It is only the limited area around the intervention place that is important and it can be defined according to the character of the crisis. The last dimension of the information relevant to dealing with a crisis situation is aggregation. The data is provided in aggregated form, for example as specific maps or map layers. However, they contain also specific data sets that could be irrelevant to the character of a particular intervention location or to the crisis itself. The way to avoid unnecessary information is to use adaptive mapping (Kubíček et al., 2010).

3.4 Psychological Aspects

There is a new belief that even despite the devastating impact of disasters, substantial lack of resources, and general chaos, there is still a possibility of carrying out some actions that will serve in maintaining at least the basic integrity of the human society and its dignity. Psychological aspects are usually very important for dealing with crises. All activities of crisis management are performed under substantial time and psychological pressure. Intervention commanders work and make decisions in fear of their possible failure. They often have insufficient and inaccurate information. Other problems arise from lack of necessary resources. The basic requirements of life may sometimes be restricted under the influence of all these factors.

3.5 Using of Standards

Unified Modelling Language (UML) is a standardized modelling language used in the field of software engineering. Two diagrams are especially suitable for process modelling: *Use Case Diagram* and *Activity Diagram*.

Business Process Modelling Notation (BPMN) (Silver, 2009) provides a notation that is readily understandable by all business users. This way, BPMN creates a standardized bridge over the gap between the business process design and process implementation.

Web Services Business Process Execution Language (WS-BPEL) defines a model and a grammar for describing the behaviour of a business process based on interactions between the process and its partners (Jordan and Evdemon, 2007). WS-BPEL introduces a mechanism to define how individual or composite activities within a unit of work are to be compensated in cases where exceptions occur or a partner requests reversal.

4 CASE STUDY

To demonstrate the practical use of the process-oriented methodology in crisis management a typical activity STC - 05/IZS called “Finding an object that is suspicious to contain B-agents and toxins” is chosen. Typical activities describe cooperation of the Integrated Rescue System (IRS) components for joint intervention (Kubíček et al., 2010). This group of documents is released by the Directorate of Fire Brigade of the Czech Republic.

4.1 Application of Methodology

At *Identifying phase* it is important to understand the research problems and identify the individual processes. The main output is a good theoretical preparation for the next phase of the methodology. Intervention from the perspective of the Intervention commander begins when the commander arrives into the site of finding a subject that is suspicious of the presence of B-agents or toxins. The Intervention commander immediately conducts an *evaluation of the situation*. In case of a threat the intervention commander decides about organization of the intervention and future joint actions. *Coordination with emergency medical service* (EMS) provides medical assistance to affected civilians and rescue teams. In parallel with this activity intervention units carry out in the affected area *disinfection and medical examination of people* and *decontamination of the area*, especially suspicious object and location findings. When all of these activities are finished, the intervention commander *ends the intervention*. At the moment ends a common intervention of IRS components.

Consecutively, there is the *Modelling phase*. Based on the previous proposal the process model is created (Figure 2). The diagram shows the order in which activities are behind, what data streams flow between them and what the outcomes of the process are. The process is modelled in BPMN notation. This phase also includes a simulation and process optimization possibility. Simulation can show the bottlenecks as well as lead the user through the individual process steps to check whether the process is modelled in accordance with the user’s wishes. This phase results in verified, validated and simulated processes (Mak et al., 1999).

To *Configuration* the process model means that processes first need to be supplemented by specific data types, especially in the simplified form. These forms wander through processes and every activity adds new information to them. This phase of the process-oriented methodology also involves making key performance indicators and the monitoring model, which will monitor and evaluate the deployed process. In order to implement instances of automated processes, it is necessary to convert the processes into a format that is computing processable. For this purpose Business Process Executive Language (BPEL) is used. The created process is then deployed into a process server.

The *Execution/Monitoring phase* is essential to execute and monitor processes and to visualize conditions of the process instances. The monitoring process is an important mechanism to provide accurate and timely information on conditions of process instances. Important modules are primarily *Sequence diagram of human work, Detailed activity description* and *Key performance indicators*.

The last phase is the *Optimization*. The basics for this phase are data from processes monitoring that are used to evaluate and optimize business process models and their implementations. Execution logs are evaluated by using business activity monitoring and process mining techniques. These techniques aim to identify the quality of business process models and adequacy of the execution environment. For instance, business activity monitoring might reveal that a certain activity takes too long due to shortage of resources required to conduct it.

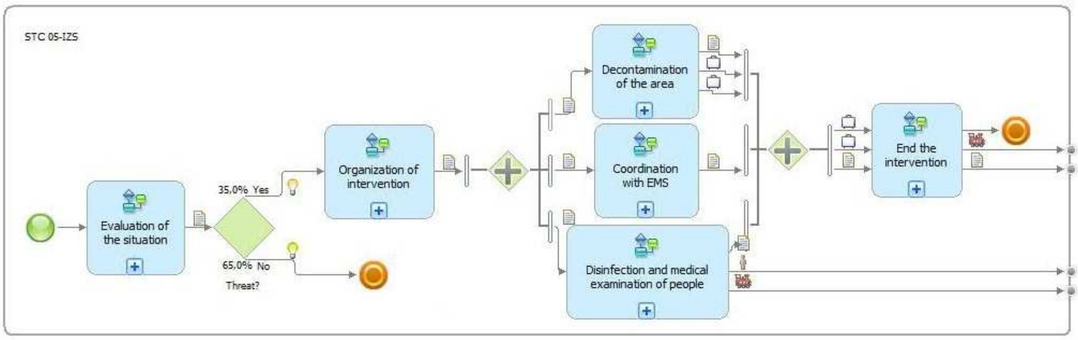

Figure 2: Process model of typical activity STČ – 05/IZS

4.2 Business Process Management Suite

The overall architecture is often composed of a set of tools covering everything necessary to deploy complex processes in the organization. Such a software package is called *Business Process Management Suite* (BPMS). Unlike the first generation instrument, which was conceived as a compilation of several separate programs, by far did not cover the requirements of the complex architecture necessary for the deployment of processes. Current systems already offer comprehensive and holistic options tools with an intuitive user interface, which covers complex architecture requirements.

For this case study IBM WebSphere software was used. The software includes programs that cover the elements of architecture describing the process framework for crisis management (Ludík and Ráček, 2011). There are many other solutions, of course.

5 CONCLUSIONS

The primary contribution of this paper is the innovative, process-oriented methodology. The methodology is described in terms of phases, user roles and work products. The paper also describes set of recommendations, which should be applied when methodology is used on crisis management processes. These are based on practical experiences when solving the research plan called *Dynamic Geovisualisation in Crises Management* (Kubíček et al., 2010; Ludík and Ráček, 2011). The paper also illustrates the practical use of the methodology in real situation called "Finding an object that is suspicious to contain B-agents and toxins".

It is appropriate to emphasis on adequate software support during the use of methodology. This support is provided by *Business Process Management Suite* (BPMS), where different tools support different methodology phases. In case of a comprehensive crisis management system it is necessary to take the close interoperability to GIS or other systems used by the IRS into account. Therefore it is recommended to add the global architecture which will illustrate the overall deployment of the system based on processes.

The subsequent objective of this research is to define in detail the methodology phases in terms of individual tasks and their links to each other. This is related to the assignment of responsibilities for these tasks. Similarly, detailed description of the role associated with implementing the methodology in terms of ICT and crisis management is needed. The final aim is to describe the task inputs and outputs in detail in terms of work products and determine whether all information is available at the right time.

ACKNOWLEDGEMENTS

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EMEE – WELL-FOUNDED FEEDBACK IN LEARNING MANAGEMENT SYSTEMS

Martin Komenda, Lucie Pekárková, Daniel Schwarz

Abstract

This paper gives an introduction to effective monitoring and evaluation of education. Well-founded feedback called EMEE (Effective Monitoring and Evaluation of Education) represents an interdisciplinary project combining an informatics approach with mathematical and pedagogical methods. The EMEE idea is based on an innovative feedback method integrated into an appropriate learning management system. The added value lies in new information for teachers discovered by data mining, statistical and analytical data processing. The result will be clearly visualized in diagrammatic form (graphs and tables). EMEE functionalities will be available in the most widespread and most popular LMS Moodle. All fundamental principles including the conceptual database model are described in this paper.

Key words: *feedback, learning management system, analytic tool, e-learning, Moodle*

1 INTRODUCTION

Electronic support of teaching contains many sophisticated features for improving education. A learning management system (LMS) is a specialized online environment, which covers basic and advanced e-learning innovative elements and often is connected to the agenda of the administration. The term LMS represents software for delivering, tracking and managing training. LMSs range from systems for managing training records to software for distributing courses over the Internet and offering features for online collaboration. In many instances, corporate training departments purchase LMSs to automate record-keeping as well as the registration of employees for classroom and online courses. These systems are very important in education in particular. Using an LMS can offer many benefits. It provides uniform learning content, enriches the learning experience, increases student participation, manages content delivery and, by using standardized content formats, users can share course content. The business use of an LMS can also reduce training costs, increase employee competency and the flexibility of a training agenda, decrease employee turnover and manage learning facilities in conjunction with human resources goals. Due to survey (1) instructors and students believed that an LMS improved teaching and learning, although students were less positive about the effect of an LMS on instructors' teaching. There are also other benefits of using an LMS in education that are proven by this survey – for instructors it is improvement in communication with students and for students it is efficiency (saving time). However, 26% of instructors choose "efficiency (saves time)", which indicates that efficiency is important to many instructors as well as their students.

An LMS may contain information about how long it would take to work through self-study material and the length of face-to-face courses. An LMS may give immediate access to e-learning material, it may enable people to register for a face-to-face course, and it may dispatch other forms of study material. An LMS may monitor progress and provide a record for learners on how they are doing, perhaps against their own original target or against others. For the learner the LMS gives access, feedback, and a planning tool (2). One could use the data administrated in an LMS to predict the time required by the learner as a total and in hours per week, given a target for when the training has to be complete. As LMSs continue to evolve and gain popularity, further research is needed to help instructors and students identify the most effective ways to use these technologies to improve teaching and learning, and not only in higher education. There seems to be great opportunity to develop an original feedback module for a convenient and well-arranged overview of students' activities and results.

1.1 LMS feedback functions and analytic tools

Many educators expend enormous amounts of effort in designing their learning to maximize the value of those interactions. Regardless of the approach taken, a series of questions consistently arises: How effective is the course? How can the needs of learners be better supported? What interactions are effective? How can they be further improved?

The evaluation and analysis of learning has suffered from: the limited quantity of data that busy students and instructors are willing to share at the end of a course; the limited quality of this self-reported, retrospective data; and a significant delay (normally at least one semester) between the events being reported and the implementation of an intervention. However, as an increasingly large number of educational resources move online, an unprecedented amount of data surrounding these interactions is becoming available. For example, the amount of time spent reading content online can easily be captured by an LMS. When, why and with whom learners are connecting is also logged in discussion forums and social networking sites. There exist numerous other parameters which can be very useful for applications of data mining methods and subsequent appropriate analytical processing. The EMEE concept works with data stored in LMSs and effectively visualizes interesting relations and significant differences. It is a new kind of educational technology, which can be used to improve learning and teaching. It draws from, and is closely tied to, a series of other fields of study including business intelligence, web analytics, academic analytics, educational data mining, and action analytics (3).

The challenge with respect to data-gathering hardware and software is the integration of these diverse data sources. Open architecture solutions are therefore required that are capable of scraping data, information, and context from administrative and academic systems as well as from structured and unstructured data, information, and context contained in assessment solutions (4). If LMS data were correlated with additional information gathered in other systems, a richer picture of the student learning experience, instructor adoption, and institutional usage could be generated. It could in fact be possible to track individual activity throughout the entire student life cycle – from initial admission, through course progression, and finally graduation and employment transitions (5).

2 QUALITY OF EDUCATION

The World Declaration on Education for All (1990) and the Dakar Framework for Action (2000) – the two most recent United Nations conference declarations focusing on education – recognize quality as a prime condition for achieving Education for All. The Dakar Framework affirms that quality is "at the heart of education". It goes on to say, "What takes place in classrooms and other learning environments is fundamentally important to the future well-being of children, young people and adults. A quality education is one that satisfies basic learning needs and enriches the lives of learners and their overall experience of living."

Despite a growing consensus about the importance of quality, there is much less agreement on what the concept means in practice. Two principles, however, characterize most attempts to define the quality of education. The first, which identifies learners' cognitive development as the major explicit objective of all education systems, sees the success with which learners achieve this as one indicator of their quality. The second emphasizes the role of education in promoting commonly shared values, and creative and emotional development – objectives whose achievement is much more difficult to assess (6).

One of the most important aspects to ensuring the rising quality of education, and not only in the academic sphere, is feedback from students to the teacher. Today many teachers use various online environments such as LMS systems. The feedback process without computer assistance is extremely time-consuming, and there is no complex reporting application that can be fully integrated into learning management systems and provide substantiated reports to teachers.

2.1 Importance of feedback

Student support and cooperation in education is one of the areas in which e-learning differs from traditional teaching approaches. In the event that education is mostly or completely in the form of distance learning, students learn mostly by interaction with the system. Laurillard's conversational theory promotes an approach where the education is accompanied by interactions between the student and teacher. This theory also emphasizes the constructive and meaningful feedback that allows students to reflect on teaching methods and materials (7).

Feedback helps teachers to better set targets for their students, creates independent student learners and, in the process, raises students' performance levels. In order to have sustainable change in teachers' practice they must be provided with ongoing opportunities for learning, including trying new strategies, followed by reflection and discussion with peers. Throughout feedback teachers can think and work "smarter," structure learning experiences that fully engage the learner, and, most of all, provide the steps for the intended one. Learning involves taking risks, supporting each other, looking for evidence of progress and adjusting one's plans (8). The importance of feedback also lies in teachers' perceptions of the collective efficacy of the teachers in their schools. Appraisal and feedback have a strong positive influence on teachers and their work. Teachers report that it increases their job satisfaction and, to some degree, their job security, and it significantly increases their development as teachers. The greater the emphasis on specific aspects of teacher appraisal and feedback, the greater the change in teachers' practices to improve their teaching. In some instances, more emphasis in school evaluations on certain aspects of teaching is linked to an emphasis on these aspects in teacher appraisal and feedback which, in turn, leads to further changes in teachers' reported teaching practices (9).

3 EFFECTIVE MONITORING AND EVALUATION OF EDUCATION

The underlying concept of EMEE is the idea of a clear arrangement of different feedback features, giving the teacher well-founded information on student behavior during the education cycle. A standard component of the learning management system (LMS) is access to statistics for different learning objects which, when combined with other information available, can be used for interesting statistical and analytical investigations. The key in this is the utilization of all data of informative value related to student activities, with subsequent storing of the data in a newly designed database structure. Through sophisticated mechanisms and selected data retrieval methods, student behavior can be mapped during different stages of studies – typically in semester cycles. The application of these principles in different learning management systems is specific mostly because each environment has, to a certain degree, a different data structure and has been created by using a different programming tool.

3.1 Conceptual data model

The basis conceived for the design of the database solution is a conceptual data model. The advantage of the scheme is its generality and hence the independence of the selected implementation. A direct implication is that the scheme can be applied in any environment regardless of the programming tool and database type used. The model defines relations between different entities, selected in this case to ensure that the entire learning cycle can be generally described.

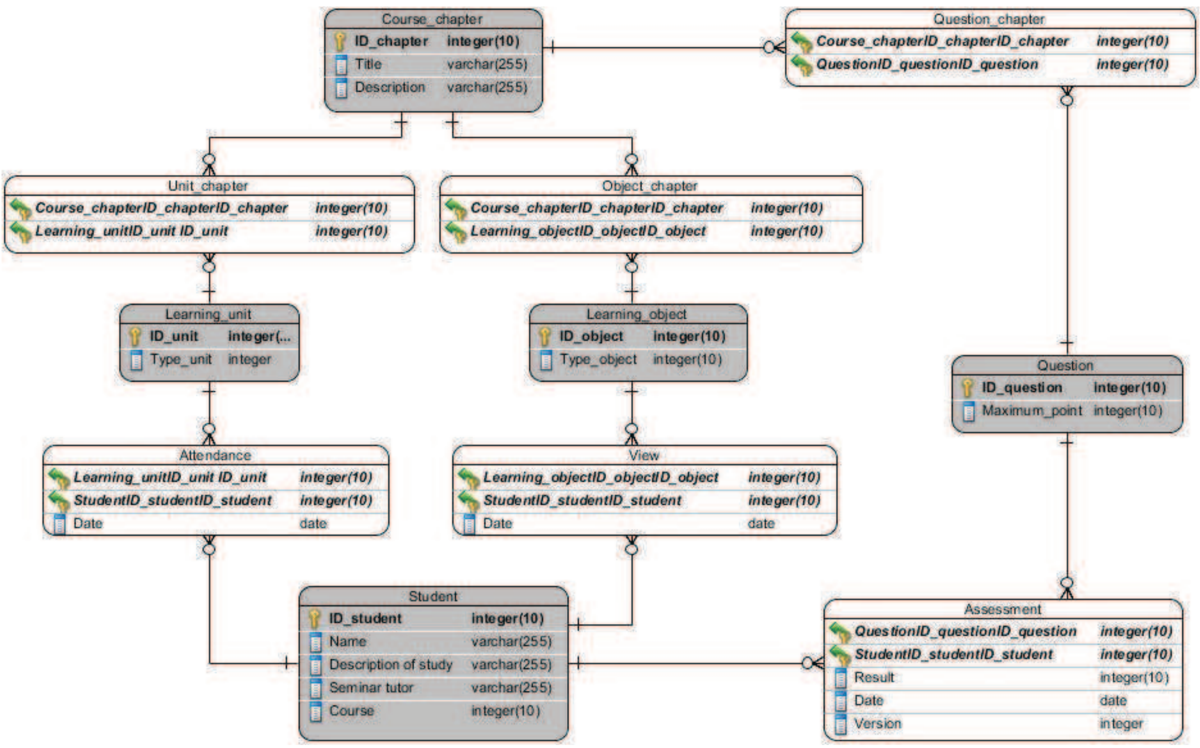

Fig.1. Conceptual model showing how data is organized in EMEE. For illustration, associative entities are differentiated and marked with a white background.

The *Student* entity describes through different attributes all major features which are necessary to know for further processing. Initial parameters are unambiguous student identification, including name, description of studies, teacher and course repetition indicator.

The *Course_chapter* entity determines a wider cycle for the topic during the semester. It is clearly identified through its *ID_chapter*, and for the sake of clarity and easier understanding also the *Title* and *Description* attributes are at hand. It is always a compact learning area to which learning objects and student activities are related.

The actual learning objects are represented in the model by the *Learning_object* entity, which contains, besides the primary key *ID_object*, the *Type_object* attribute where numeric values are used to specify the type of learning material (textbook, lecture materials, exercise materials, teaching tutorials, video records, etc.).

Lectures, exercises and seminars are represented by the *Learning_unit* entity which, again, contains the *Type_unit* attribute besides the primary key *ID_unit* for precise identification of the learning unit. Examples include a lecture, a seminar, or practical training.

The key student activity during the semester is shown through coupling (associative) entities *Attendance* and *View*. In the *Attendance* entity, a new record appears if the student has not been physically present at a lecture or training. In the *View* entity, a new record appears if the student has accessed the particular learning object.

It is logical that each learning object and each learning unit are related to one of the thematic blocks. The link between the learning chapter and learning unit/object is represented by coupling entities *Unit_chapter* and/or *Object_chapter*.

Different questions forming part of different test specifications are represented by the *Question* entity. Besides the primary key *ID_question*, this entity features the *Maximum* attributes (maximum possible point gain). If the student comes to a test, the associative entity *Assessment* keeps information on the point gain of the respective student within different questions of the task. It is obvious that each question must be incorporated into any of the learning chapters. This relationship is represented by the *Question_chapter* coupling entity.

3.2 Work with data

The model designed in this way enables access to data via SQL queries. Variability and possible modifications of the database structure are very easy thanks to the generality of the design, so it can be customized for the LMS system which is in use. A practical showcase of access to data are the following examples, applied within the EMEE pilot project at FI MU:

Example 1

```
SELECT DISTINCT   question.maximum_point,
                  assessment.points,
                  assessment.student_ID

FROM              chapter_course,
                  question_chapter,
                  question,
                  assessment

WHERE             chapter_course.id_chapter=question_chapter.id_chapter AND
                  question_chapter.id_question=question.id_question AND
                  question.id_question=assessment.id_question AND
                  chapter_course.id_chapter= 'chapter_11'
ORDER BY          ID
```

The SQL query in example 1 returns gained points and possible maximums ordered according to the *ID_student* attribute. These are only questions belonging to thematic chapter 11.

Example 2

SELECT *assessment.id,*
assessment.points,
assessment.id_question

FROM *assessment,*
question

WHERE *assessment.id_question= question.id_question* **AND**
assessment.id='123456' **AND**
assessment.date='2011_01_05'

The SQL query in example 2 returns the point count for different questions on a test from 5 January 2011 answered by a student with identification number 123456.

3.3 Practical use

EMEE – Effective Monitoring and Evaluation of Education has been already applied in practice within a large-capacity course at the Faculty of Informatics of Masaryk University where the data pool for further processing was provided by the Information System of Masaryk University, belonging to the LMS systems category. Data collection, editing, organization in the database and analysis were prepared, to a large degree, on an experimental basis by adopting manual procedures and simple scripts (10). The output of this pilot project was a set of statistical and analytical investigations which gave the teacher a realistic view of the teaching and vital feedback. An example can be found in the two charts showing the application output for multiple statistical and analytical methods for available data. Figure 2 shows the average point gain of students expressed in percentage points on questions from the respective chapter. The students were divided into two groups: students attending a lecture devoted to a chapter topic (grey column) and students not attending (white column). The total of all columns of the respective color always indicates 100% = all attending/non-attending students in the lecture.

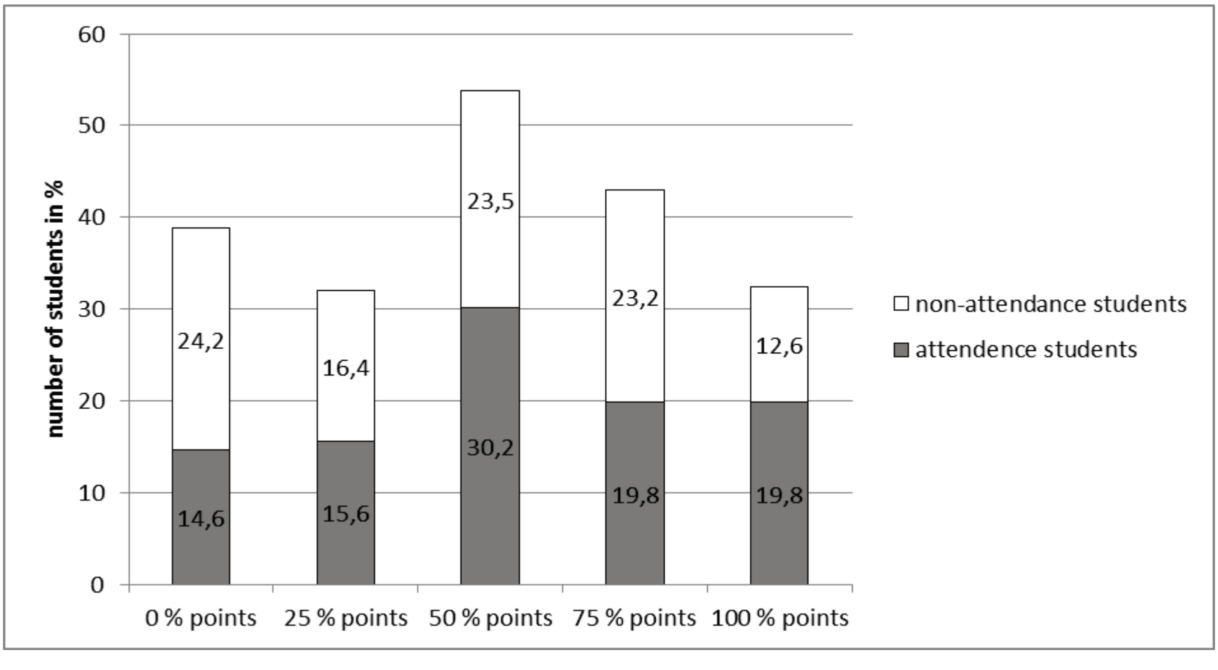

Fig.2. Chart showing correlation between average results on questions from the respective chapter on attendance of a lecture (11).

The chart in figure 3 demonstrates the point gain of students in a final test (maximum 40 points) depending on how active they were over their learning cycle. The students were divided into four groups:

- Active students – students who have attended at least 75% of lectures;
- Lightly active students – students who have attended at least 50% but less than 75% of lectures;
- Lightly passive students – students who have attended at least 25% but less than 50% of lectures;
- Passive students – students who attended less than 25% of lectures.

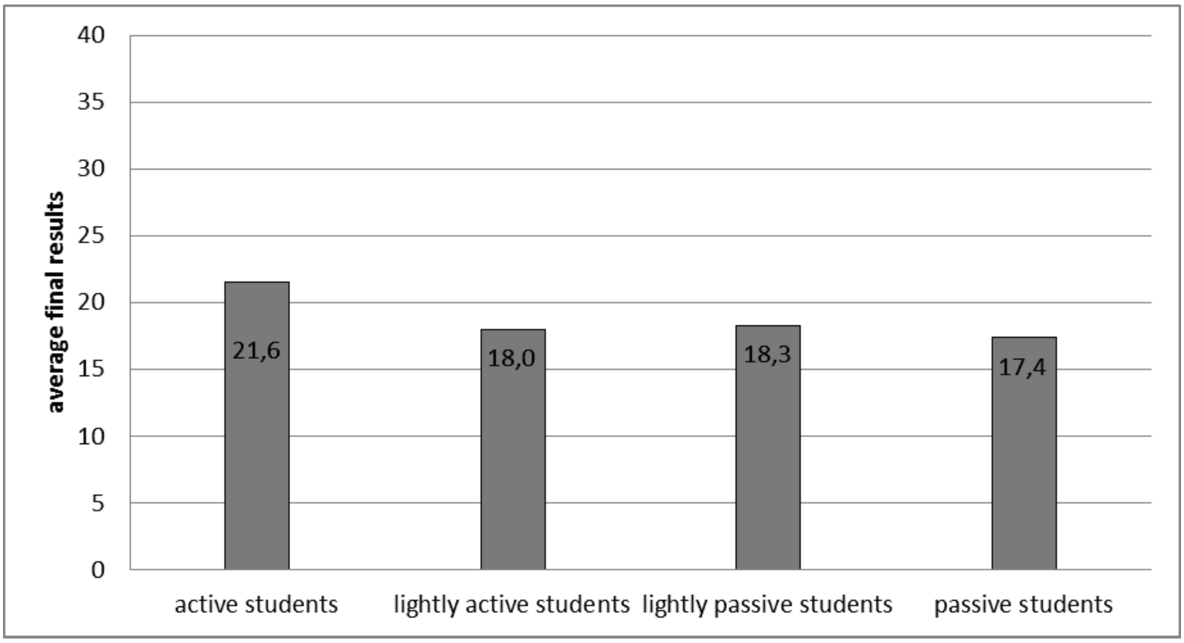

Fig.3. Chart showing correlation between average results and student activity during lessons (11).

A comprehensive list of charts and tables from the project at the Faculty of Informatics can be found in the diploma thesis of M. Komenda with the title Monitoring and Evaluation of Education Forms in IT.

3.4 Generalization of EMEE

The previous chapter provides evidence that the EMEE concept is fully applicable in practice. One fact is that almost all adjustments related to data retrieval from the LMS system as well as subsequent processing have not yet had any conceptual or systemic solution. Therefore, it is desirable to take a more general look at EMEE and calculate with the idea of maximum possible automation. This would mean that for example selected functions could be available in the teacher's standard environment (LMS) which the teacher is using in his/her e-learning agenda. Based on past experience, EMEE can be divided into the following four phases:

1. Data retrieval from LMS on student behavior during the learning cycle.
2. Selection of useful data and its organization in the database.
3. Statistical and analytical processing.
4. Presentation of output.

Each of the above steps correlates to a certain degree with the environment in which EMEE is to be implemented. Now it is essential to design a specific application enabling efficient and effective feedback to the teacher on his/her students. The technical solution to communication with the selected LMS is subject to further development. Since the architecture of LMS systems is not standardized and hence varies significantly, no uniform and fully compatible solution can be developed. Development will always have to be customized for the system supporting the e-learning agenda. What will play the key role prior to implementation will certainly be the analysis and collection of requirements from teachers who themselves want to use this functionality (10).

4 INTEGRATION OF EMEE INTO THE MOODLE SYSTEM

Selection of the right development and integration system for EMEE was a relatively easy task. In recent years, the popularity of open-source software products has been growing. The most popular choice in the area of learning management systems is without any doubt the Moodle LMS. Also available of course are alternatives such as Claroline, Dokeos, ILIAS, ATutor, SAKAIa, etc. In its number of installations and thanks to its large community, Moodle can confidently claim the leading role. Teachers and students all over the world know and enjoy this e-learning management system. In the Czech academic environment Moodle is also widely used, which is why it was selected as the environment for which the actual EMEE module was developed and integrated. The new separate module Moodle-EMEE will fully correspond with the license policy of Moodle and will be distributed free of charge in the open-source format under the GNU General Public License.

Like most software solutions, also Moodle-EMEE will undergo a development life cycle. One essential development phase is demand specification. This phase is crucial for successful completion and implementation. Extremely high emphasis will be placed on correct specifications to ensure seamless application. For this reason, a survey has been carried out among the public with the objective of collecting suggestions and ideas about the functionality of the model from the teachers for who this model will be relevant. As the function and output variability connected with data describing student behavior is rather broad, a targeted feedback should provide a list of the most desired features to be used as the core of the first version of the Moodle-EMEE analytical model. Tutors and teachers will have the opportunity to influence how the application will look in practice.

The target group in this survey are experts and senior users of the e-learning tool at universities.

- Users of LMS Moodle – teacher community working with the open-source system Moodle who attended the MoodleMoot.cz 2011 conference.
- Users of LMS systems from academic and commercial institutions (collaboration with Pragodata Consulting s.r.o.).
- Selected teachers across the MEFANET education network (pooling all Czech and Slovak medical faculties).
- Selected teachers working at the Institute of Biostatistics and Analyses at Masaryk University.
- Attendees of the Summer School of Applied Informatics 2011 in Bedřichov.
- Teachers from LaSARIS (Lab Software Architectures and Information Systems).
- Selected active teachers at Masaryk University engaged in e-learning over the long run (10).

5 CONCLUSION

This paper described a brand-new EMEE concept which shifts learning feedback to better optimization from the point of view of the end user. Without the need for complicated and often bothersome questionnaires and surveys, the teachers will have a tool providing a well-founded and hence valuable picture of their teaching. The pilot experiment showed clearly that the proposed principles are applicable in practice and the output opens not only an objective insight into student behavior, but also follow-up modification of teaching methods. Another logical step is the development of a new module for the LMS system environment – specifically for Moodle. Moodle-EMEE will give teachers feedback options not only on student activity but also and firstly on their own teaching. The entire chart and table output will be presented in anonymized form, used only for optimization purposes and continuous quality improvements in the teaching process. If successfully applied in the Moodle system, further spill-overs into closed university environments are foreseen. A vital prerequisite for future incorporation of advanced functionalities and new requirements is collaboration between teachers prior to implementation.

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Integrace EMEE[1] do systémů pro řízení výuky

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Abstrakt

Koncept EMEE (Effective Monitoring and Evaluation of Education) označuje inovativní metodu vyhodnocování vzdělávacího procesu tak, že umožnuje sledovat aktivity studentů během výuky. Přidaná hodnota tohoto konceptu je v přehledném statistickém a analytickém rozboru, který pedagogům poskytne podloženou zpětnou vazbu. Pro stanovení základní funkcionality modulu EMEE je realizován plošný průzkum ve spolupráci s vyučujícími na vysokých školách s jednoznačným cílem zjistit, o které konkrétní výstupy je největší zájem. Tyto výstupy pak budou implementovány jako součást nového modulu do prostředí systému pro správu výuky. Jako pilotní systém byl zvolen Moodle především z důvodu své otevřenosti a dostupnosti.

Abstract

The EMEE idea represents innovative method of education evaluation with the use of students' activities monitoring during classes. The EMEE added value lies in clear statistical and analytical processing, which ensures substantiated feedback. EMEE core functionalities will be based on the global survey, where teachers and e-learning experts will participate. The goal is to determine the most required EMEE outputs and properties, which will be consequently implemented into appropriate learning management system. The LMS Moodle was chosen as a pilot LMS environment, because it's open source and freely available.

Klíčová slova

e-learning, analýza dat, metrika, systém pro správu výuky, vzdělávání, průzkum, zpětná vazba

Key words

e-learning, data analysis, metric, learning management system, education, survey, feedback

1 Úvod

Elektronická forma vzdělávání se stala za poslední desetiletí velmi rozšířenou a oblíbenou. Otázkou však zůstává, zda pokrokové a inovativní pedagogické metody v kombinaci s počítačově orientovanou podporou přináší adekvátní zlepšení úrovně kvality studia. Klíčovou roli při evaluaci vzdělávání hraje zpětná vazba, která však bývá stále upozaďována, a tak vyučující nemají možnost objektivně a na základě podložených informací získat hodnocení svých studijních postupů a konceptů výuky.

Studentská podpora a spolupráce při výuce je jednou z oblastí, kterou se e-learning diametrálně liší od tradičních výukových přístupů. V případě, kdy výuka probíhá z větší části nebo kompletně distanční formou, se studenti učí převážně pouhou interakcí se systémem. Například Laurillardova konverzační teorie prosazuje přístup, kdy je výuka doprovázena interakcemi mezi studentem a pedagogem. Tato teorie také klade důraz konstruktivní a smysluplnou zpětnou vazbu, která umožňuje studentům reflexi na výukové metody a materiály [1]. Myšlenka EMEE je založena právě na vypovídající a podložené zpětné vazbě.

E-learningová agenda je velmi úzce spojena se systémy označovanými jako LMS (Learning Management System - systém pro řízení výuky), které umožňují v plném rozsahu pedagogům relativně snadno a bez nutnosti znalosti programovacích jazyků využívat všech jejích možností. LMS obecně přináší spoustu výhod nejen tvůrcům obsahu, vyučujícím, ale i studentům a v neposlední řadě také managementu školy. Prvky elektronické podpory vzdělávání lze nalézt v různých podobách – pomůcka ve formě CD, intranetové řešení nebo webové stránky. Zdaleka ne všechny formy jsou ale vhodné a některé nemohou naplno využít všech vlastností a výhod. Z tohoto pohledu je začlenění e-learningové podpory do LMS

[1] EMEE – Effective Monitoring and Evaluation of Education

patrně nejefektivnější volbou. Pokud je e-learning součástí LMS, organizace (akademická instituce, komerční společnost, atd.) má kompletní přehled o dostupnosti a aktuálnosti kurzů a co více, lze vše efektivně navázat na systém řízení výuky. Veškerá data o kurzech, vyučujících a samotných studentech je možné provázat se širokými možnostmi elektronického vzdělávání (testy, diskusní fóra, a jiné). Každý student má v podstatě doživotní elektronický záznam o svém průběhu učení právě prostřednictvím systému pro řízení výuky, který může zahrnovat souhrnné informace o absolvovaných kurzech, jejich ukončení nebo bodové či jiné hodnocení.

Mezi další výhody využívání LMS patří:

- centralizovaná a jednotná forma předávání informací (studenti i učitelé najdou na jednom místě studijní materiály "kdykoli a kdekoli", což zohledňuje jejich individuální potřeby; LMS zajistí, že všichni vidí ten stejný dokument);
- zkoušení s sebou nese spoustu dalších výhod - ušetřené náklady za tisk testu, eliminace chyb ve vyhodnocování testů učitelům, zkrácení času čekání na výsledek (učitel již nemusí opravovat ručně stovky testů, výsledky jsou online okamžitě) a také zajištění nezávislosti zkoušení;
- zpráva o průběhu a výsledku každého účastníka kurzu (i samotní účastníci mají možnost vidět co vše je potřeba se naučit, jak je daleko na své cestě za poznáním, podívat se na záznamy o svých již ukončených kurzech a zaregistrovat sena další; pro HR odborníky je toto velká výhoda, mohou se tak zaměřit pouze na vývoj tréninkových strategií pro jejich organizace);
- snížení nákladů - organizace mohou snížit náklady na cestování (a také za jídlo a ubytování pro hostující lektory, tisk materiálů apod.);
- flexibilita - změna priorit nebo potřeb vede ke změně tréninkového programu dle aktuálních požadavků;
- monitorovací systém - k dispozici jsou obecná i detailní data o používání systému jednotlivými uživateli;
- efektivní učení - online kurzy nabízí možnosti, které tradiční prezenční kurzy nemohou nabídnout. Díky e-learningovým metodám může účastník kurzu efektivně využívat svůj čas. Tento přístup řeší problém tradičního učení, kdy ne všichni účastníci výuky jsou tématem zaujati a mohou ostatní posluchače vyrušovat [2,3].

2 Důležitost zpětné vazby

Zpětná vazba je nezbytnou součástí efektivního učení. Pomáhá studentům pochopit probíranou látku a poskytne jim srozumitelný návod, jak zlepšit vlastní učení. Je důležité uvědomit si, že stejně to platí i obráceně. Jedním z mnoha způsobů, jak hodnotit vzdělávací proces je zpětná vazba. Kladnou zpětnou vazbou se rozumí vliv vedoucí k zesílení řízené činnosti (např. pochvala vede k častějšímu výskytu odměněného chování), naopak záporná zpětná vazba zeslabuje danou činnost (trest snižuje četnost trestaného chování). Poskytování zpětné vazby je tedy nejen podstatou formativního (průběžného) hodnocení, ale také klíčovou složkou hodnocení vlastní výuky:

- pozitivní zpětná vazba vede k potvrzení kvality pedagogické činnosti (např. dobré výsledky při testu za předpokladu, že nebyl zadán chybně, např. příliš snadný test)
- negativní zpětná vazba je informací o problémech, které je třeba identifikovat a odstranit (např. špatné výsledky při testu u většiny posluchačů za předpokladu, že test nebyl zadán chybně, např. příliš náročný test)

Učiteli bez snahy o účinnou zpětnou vazbu hrozí, že bude pracovat neadekvátně a chybně. Proto zkušení učitelé zpětnou vazbu vyhledávají a záměrně navozují podmínky pro její realizaci. Podmínkami jsou míněny zkušební aktivity učitele. O kvalitě (nedostatcích) učitelovy práce se lze tedy nejlépe přesvědčit zkoušením posluchačů, jejich hodnocením [4].

Z výzkumu OECD (Organisation for Economic Co-operation and Development) vyplývá následující:

- Hodnocení a zpětná vazba mají silný pozitivní vliv na učitele a jejich práci. Učitelé uvádějí, že díky zpětné vazbě se zvyšuje jejich uspokojení z odvedené práce a zpětná vazba výrazně zvyšuje jejich vývoj.
- Čím větší je důraz na zpětnou vazbu a hodnocení učitele, tím větší je změna v učitelově praxi, která vede ke zlepšení výuky.
- Řada zemí má relativně slabou strukturu hodnocení a neumí využívat hodnocení školy nebo učitele a zpětnou vazbu.
- Většina učitelů pracuje ve školách, které nenabízejí odměny nebo vůbec nezjišťují, jaké kdo vyvíjí úsilí. Tři čtvrtiny učitelů uvedlo, že by nikdo nepoznal, že zlepšili kvalitu svoji práce. Obdobný počet pak uvedl, že nedostane žádné uznání za to, že je inovativnější ve výuce.
- Většina učitelů pracuje ve školách, které neodměňují efektivní učitele a nepropouští ty, kteří nejsou tak dobří [5].

Nejen na univerzitách by se zpětné vazbě k výuce měla věnovat zvláštní pozornost. Nejen studenti totiž mohou upozornit na aspekty výuky, které by bylo třeba vylepšit, vyučující si mohou vytvořit přesnější obraz o tom, které části výuky považují studenti za přínosné a které nikoliv, což může výrazně přispět ke zkvalitnění výuky. Využívání zpětné vazby tak může vést ke zvyšování úrovně studijních programů. Nekvalitní nebo neexistující zpětná vazba je v určitém smyslu známkou zpátečnictví, neboť nemůže navodit změny nebo zlepšení ve výuce. Na základě výsledků zpětné vazby může být upravena struktura učebních postupů, výuky jednotlivých předmětů, a dosáhnout tak maximální efektivity studia při zachování kvality výuky.

Co se týče možností různých LMS v oblasti statistik a analytických reportů, není tato oblast zatím velmi podporována. Některé LMS nabízí možnost jednotlivě zjistit, kdo nebo kdy přistupoval ke studijním materiálům, kdy byl naposledy přihlášen nebo kdy odevzdal úkol. To ale pro analýzu chování studentů, zpětnou vazbu a vůbec analytický report celého kurzu nestačí. Právě z důvodů zcela inovativního přístupu konceptu EMEE je snahou navrhnout obecnou funkční metodiku, která by poskytla jasný a srozumitelný návod, jak lze implementovat EMEE do LMS systémů. Obecnost vychází z faktu, že systémy pro řízení výuky jsou vyvíjeny různými způsoby (programovací jazyk, databáze, funkcionalita), a nelze tedy unifikovat technické řešení využitelné nezávisle na používaném systému pro podporu e-learningu.

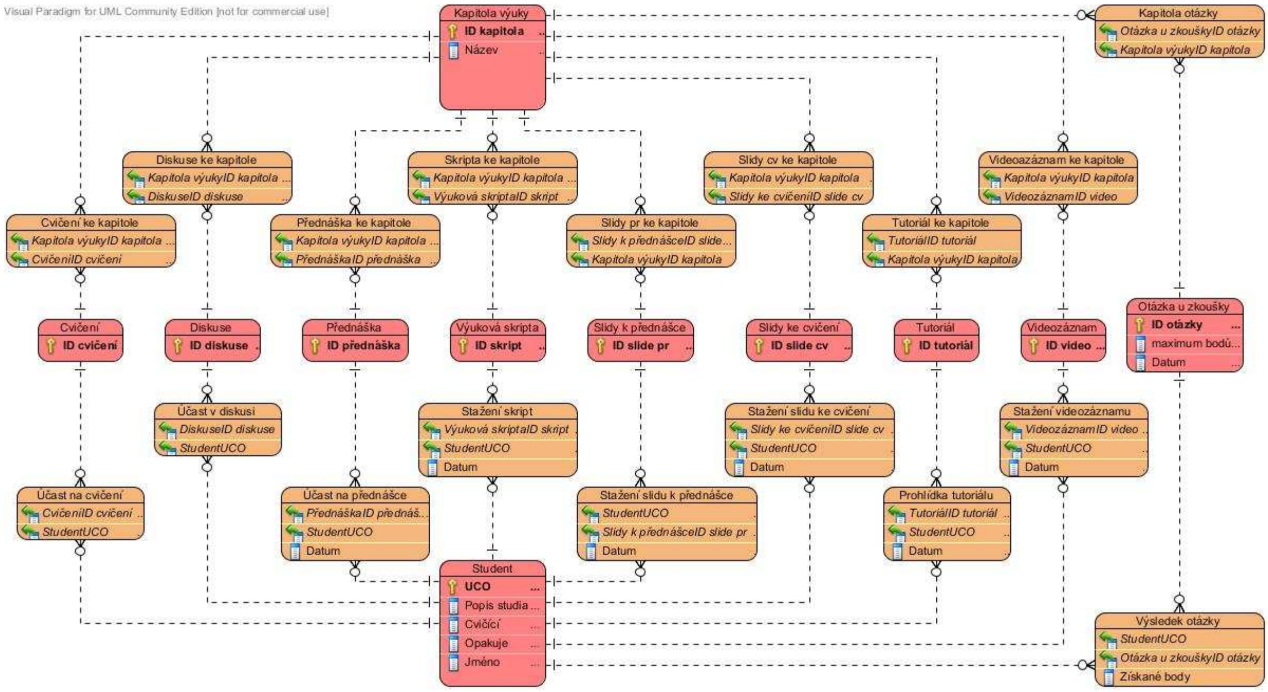
3 EMEE a systémy pro správu výuky

EMEE - sledování a hodnocení vzdělávání přináší inovativní přístup z pohledu zajištění zpětné vazby pro pedagogy. Prostřednictvím sofistikovaných efektivních mechanismů je možné mapovat chování studentů v průběhu jednotlivých etap studia – typicky v jednotlivých semestrálních cyklech.

Celý koncept byl již v praxi vyzkoušen na velkokapacitním kurzu na Fakultě informatiky Masarykovy univerzity, kde základní data pro další zpracování poskytl Informační systém Masarykovy univerzity (zkráceně IS MU), který je řazen právě do kategorie zmiňovaných LMS systémů. Statistiky přístupu jednotlivých studentů ke všem druhům materiálů dostupných prostřednictvím IS MU hrály naprosto klíčovou roli v první fázi – při sběru dat. Další důležitou skupinu nasbíraných informací tvořila samotná účast studentů na přednáškách a praktických seminářích. Každý student potvrdil svou přítomnost svým podpisem na dané prezenční listině. Všechny seznamy přítomných studentů byly následně převedeny do elektronické formy a spolu s daty z LMS poskytly základ pro další zpracování.

Z informatického pohledu je zajímavá část zabývající se organizací dat. Po delších úvahách se pro pochopení a celkovou orientaci ukázala jako nezbytná potřeba konceptuálního modelu, který bude sloužit jako primární podklad pro praktickou realizaci databázového řešení. Právě databáze umožňuje relativně snadno uložit všechna data a pomocí vhodných SQL dotazů získat v požadovaném formátu informace pro další analýzu. Konceptuální model byl vzorem pro vytvoření databáze založené na systému MySQL. Toto multiplatformní řešení bylo zvoleno především pro svou širokou implementovatelnost a výkonnost.

MySQL je podporován systémy MAC OS X, Linux, Solaris i MS Windows a jelikož se řadí mezi volně šiřitelný software, má vysoký podíl na v současné době používaných databázích.



Obr. 1. Konceptuální model pro organizaci nasbíraných dat

Samotné výsledky, které jsou reakcí na různé databázové dotazy, jsou ale bez dalšího analytického zpracování a komentáře zcela bezcenné. Proto byly v závěrečné fázi pro detailnější rozbor použity dva robustní nástroje pro práci s daty, MS Excel a Statistica 9.0. Výstupem se stal souhrn grafů včetně textových popisů, který reprezentuje odpovědi na předem určené dotazy [6,7]. Příkladem je například níže uvedený SQL dotaz, který vrací počty bodů za jednotlivé otázky na zkušebním termínu konaném dne 5. 1. 2011, na které odpovídal student mající identifikační číslo 123456.

```
SELECT
        vysledek_zkousky.uco,
        vysledek_zkousky.ziskane_body,
        vysledek_zkousky.id_otazky
FROM
        vysledek_zkousky,
        otazka_u_zkousky
WHERE
        vysledek_zkousky.id_otazky= otazka_u_zkousky.id_otazky
    AND
        vysledek_zkousky.uco='123456'
    AND
        otazka_u_zkousky.datum='2011_01_05'
```

3.1 Zobecnění EMEE

Úvod této kapitoly dokumentuje, že koncept EMEE je plně aplikovatelný z praktického pohledu. Faktem zůstává, že téměř všechny úpravy související s dolováním dat z LMS systému, tak i následné zpracování neměly doposud žádné koncepční a systémové řešení. I proto je vhodné se na EMEE podívat mnohem obecněji a kalkulovat s myšlenkou maximálního zautomatizování, které by znamenalo, že pedagog by mohl mít například vybrané funkce dostupné v rámci svého standardního prostředí (LMS), které využívá při správě e-learningové agendy ve výuce.

Dle předchozích zkušeností lze EMEE rozdělit do čtyř navazujících fází:

1. Dolování dat z LMS o chování studentů během výukového cyklu.
2. Selekce užitečných dat a jejich organizace v databázi.
3. Statistické a analytické zpracování.
4. Prezentace výstupů.

Každý z výše zmíněných kroků je do velké míry závislý na prostředí, ve kterém bude EMEE implementováno. Stěžejní je v tuto chvíli navržení logického a především fungujícího mechanismu, který umožní efektivně i efektně poskytnout pedagogovi zpětnou vazbu o jeho studentech. Konkrétní technické řešení komunikace se zvoleným systémem pro řízení výuky bude předmětem dalšího vývoje. Jelikož architektura LMS systémů není standardizovaná, a tedy se značně navzájem liší, nelze vyvinout jednotné a plně kompatibilní řešení. Vždy se bude jednat o vývoj na míru právě pro zvolený systém podporující e-learningovou agendu. Klíčovou roli před samotnou implementací bude hrát zcela jistě analýza a sběr požadavků samotných pedagogů, kteří chtějí tuto funkcionalitu využívat.

4 Komplexní průzkum

Jako jedna z částí vývojového cyklu EMEE byl zařazen plošný průzkum věnovaný právě potřebám vyučujících. Jelikož je variabilita funkcí a výstupů spojená s daty popisující chování studentů poměrně široká, měla by cílená zpětná vazba určit výčet základních a nejvíce žádaných vlastností, které utvoří jádro první verze analytického modulu EMEE. Tutoři a lektoři tak mají možnost ovlivnit, jak bude v praxi tato část integrovaná do systému pro správu výuky vypadat. Komplexní průzkum lze přirovnat k jednomu z nejdůležitějších prvků vývoje softwarových produktů, kterým je specifikace požadavků. Tato fáze je obecně považována za kritickou z pohledu úspěšného dokončení vývoje a následné implementace.

Cílovou skupinu tvoří odborníci a zkušení uživatelé využívající nástroje elektronické podpory výuky na vysokých školách. Níže jsou uvedeny okruhy pedagogů, kteří jsou touto formou osloveni.

- Uživatelé LMS Moodle - komunita pedagogů pracující s open source systémem Moodle, která se účastnila konference MoodleMoot.cz 2011.
- Uživatelé LMS systémů z prostředí akademických i komerčních institucí (spolupráce se společností Pragodata Consulting s.r.o.).
- Vybraní pedagogové napříč vzdělávací sítí MEFANET (spojení všech českých a slovenských lékařských fakult).
- Pedagogové působící na Institutu biostatistiky a analýz Masarykovy univerzity.
- Účastníci Letní školy aplikované informatiky 2011 v Bedřichově.
- Pedagogové LaSARIS (Laboratoř sw architektur a informačních systémů).
- Vybraní aktivní pedagogové na Masarykově univerzitě, kteří se dlouhodobě zabývají e-learningem.

4.1 Forma plošného průzkumu

Níže jsou uvedeny jednotlivé položky dotazníkového šetření, které je rozděleno na statistický a analytický profil. Plošný průzkum je realizován pouze elektronickou formou, která významným způsobem usnadňuje následné zpracování a vyhodnocení.

Statistický profil

☐ Kdo, kdy a jak často k výukovým objektům přistupoval (první a opakovaný přístup)

☐ Výše uvedené informace mohou být přehledně rozděleny po jednotlivých časových obdobích. Například rozděleno do období po 14 dnech.

☐ Kompletní informace o prvním přístupu studentů z pohledu všech výukových objektů za celé období (semestr) včetně možnosti volit, jaké objekty budou do výstupu zahrnuty.

☐ Informace o přístupu k výukovým objektům v čase, tedy kdo a kdy přistupoval k danému objektu v několika obdobích. Například do 10 od zveřejnění, po 10 dnech od zveřejnění.

Další nápady a podněty související se zpracováním a využitím přístupových informací uveďte níže:

V případě, že vyučující zadá v modulu EMEE Moodle vazbu mezi výukovými objekty, testovými otázkami, tematickými celky a docházkou, je možné využít širokého spektra analytických výstupů.

Analytický profil

☐ Obtížnost tematických celků znázorňuje, jakých výsledků dosáhli studenti z pohledu procentuální úspěšnosti odpovědí na otázky z jednotlivých kapitol výuky. Lze tak vysledovat, které kapitoly výuky jsou pro studenty nejvíce problematické nebo které skupiny otázek činily studentům nejvíce potíží.

☐ Obtížnost testových variant – ukazuje, jak studenti zodpověděli jednotlivá zadání testů, lze tak vypozorovat, která zadání se výrazně odchylují od průměru či stanovené bodové hranice pro absolvování.

☐ Vliv účasti na přednášce / stažení výukového objektu na odpovědi při testu. Lze zhodnotit a porovnat, jak studenti odpovídali na otázky z dané kapitoly v závislosti na tom, zda se zúčastnili přednášky, popř. přistupovali k souvisejícímu výukovému objektu.

☐ Porovnání výsledků studentů v závislosti na přednášejícím/cvičícím.

☐ Porovnání výsledků studentů u závěrečného testu (řádný termín, opakované opravné termíny).

☐ Četnosti bodových hodnocení pro Jednotlivé termíny (řádný, opravný) a Jednotlivé varianty testů

☐ Porovnání výsledků skupin studentů, které jsou určeny podle aktivity v průběhu výukového období (docházka na přednášky, přístup k výukovým objektům, příspěvek do diskusního fóra,…). Například rozdělení do skupin: velmi aktivní = min. 75% docházka, min. 75% přístupů ve všem výukovým objektům dostupných v LMS k danému kurzu, další skupiny 50-75%, 25-50%, méně než 25%.

Další nápady a podněty uveďte níže

5 Závěr

Příspěvek popisuje další posun konceptu EMEE, kterým je dotazníkový průzkum ve spolupráci se zainteresovanými pedagogy na vysokých školách. Akcentována je především samotná důležitost zpětné vazby a její návaznost na funckionalitu systému pro řízení výuky. Po vyhodnocení nasbíraných informací bude následovat stanovení základní funkcionality EMEE a jeho implementace do vybraných systému pro řízení výuky. V rámci pilotního vývoje byl vybrán LMS Moodle především z důvodu své otevřenosti a tedy i dostupnosti zdrojových kódů a dokumentace. Vyvinutý modul Moodle EMEE bude korespondovat s licenční politikou Moodle a bude distribuován v otevřené formě pod obecnou veřejnou licencí GNU (General Public License).

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NEW PROCESS MANAGEMENT FOR EMERGENCY MANAGEMENT: CASE STUDY ABOUT AN ACCIDENT OF A VEHICLE TRANSPORTING DANGEROUS GOODS

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ABSTRACT

Successful organisations are interested in achieving their business policy and goals, ideally with minimal financial expenses. Process Management approach is an effective way to meet the goal. There are two groups that are focused on the field of process standardization: Object Management Group and Workflow Management Coalition, each of them focuses on the process standardization from a different point of view. For solving complex issues it is effective to combine both approaches. That is the reason why this paper shows new Process Framework for Emergency Management which can describe precisely the process deployment in the area of emergency management taking into account its process oriented methodology and complex architecture. The correctness of the Process Framework is guaranteed by continuous verification, validation and optimization of emergency processes. Applicability of the solution is shown on a case study that simulates progress of an emergency situation in the real environment.

INTRODUCTION

Emergency Management (EM), sometimes called disaster management, is a discipline of dealing with and avoiding risks. It is a discipline that involves preparing for a disaster before it happens, disaster response, as well as supporting and rebuilding the society after a natural or a human-caused disaster occurs. In general, any EM is a continuous process in which all individuals, groups and communities manage hazards in an effort to avoid or ameliorate the impact of disasters resulting from the hazards (Mak et al. 1999; Rüppel and Wagenknecht 2007). Effective EM relies on thorough integration of emergency plans at all levels of government and non-government participants (Fiala and Ministr 2007).
Process Management (PM) is a field of combining management and technology focused on aligning organizations with the requirements and needs of clients (Kubíček et al. 2010; Řepa 2007). It is a complex management approach that promotes business effectiveness and efficiency while striving for innovation, flexibility, and integration with technology (Jain and McLean 2003). PM attempts to improve processes continuously. It could therefore be described as a process optimization process.

Principles of the Emergency Management

The organisation of the emergency management varies between the EU and US. However, there are still important commonalities. The nature of emergencies means that all levels of government (federal, state, regional or local) and all sectors of society are responsible for dealing with them (Diehl et al. 2006). There generally exists a *Bottom Up* approach for requests for resources support that travel upward until appropriate resources are ensured and the incident stabilised. Each country has different legislation, procedures and obligatory documents to be followed within the EM process (Mak et al. 1999). There also exists no universal terminology within EM, not only internationally but even within the agencies across all government levels.
Coordination of Activities within the Emergency Management System is done at three levels, *Tactical*, *Operational* and *Strategic* (Rektořík 2004), and is corresponding with the generic conclusion defined by Orchestra (Klopfer and Kanellopoulos 2008).
The *Strategic Level* of the Rescue and Liquidation Works (RaLW) management is realised by standing or temporary coordinating authorities of the administration, region commissioners and Ministry of Interior – General Management of the Czech Republic Fire Rescue Corps.
On the *Operational Level*, permanent coordination and cooperation within and between individual *Integrated Rescue System* (IRS) components takes place; this includes operational centres of the basic IRS components (Fire Rescue Corps, Police and Medical Rescue Service) and dispatching centres, standing services, and oversight centres of distributive and emergency services. The *Operational and Informational Centre* manages cooperation within the RaLW with IRS documentation.

The *Tactical Level* includes activity coordination at the place of intervention and cooperation of IRS components. The intervention commander proclaims the appropriate *Level of Alert*, which predetermines the needs of the *Forces and Means* for the RaLW. The intervention commander organises the RaLW based on consultation with IRS component leaders; he or she also follows the document *Model Action Activities of the IRS Components at the Common Intervention*.

Principles of Process Management

Nowadays, there are two significant streams in the field of Process Management: i.e. *Business Process Management* presented by Object Management Group (OMG) and *Workflow Management*, which was originally created by Workflow Management Coalition (WfMC).

Business Process Management (BPM) is based on the observation that each product that a company gets to the market is the result of a number of performed activities (Weske 2007). Business processes are the key instruments to organize these activities and to improve the understanding of their interrelationships. Information technology deserves an important role in business process management, because more and more activities that a company performs are supported by it (Rüppel and Wagenknecht 2007). Business process activities can be performed manually or with a help of information systems (Sell and Braun 2009). BPM activities can in general be grouped into five categories (phases): *Design*, *Modelling*, *Execution*, *Monitoring*, and *Optimization*. They are related to each other and organized in a cyclical structure, showing their logical dependencies.

Workflow Management is built on architectural representation of a workflow management system called Workflow Reference Model, that is developed by WfMC. It identifies the most important system interfaces, covering broadly five areas of functionality between a workflow management system and its environment (Hollingsworth 2004).

Process Management and Business Processes are generally used to solve issues related to EM (Kubíček et al. 2010; Sell and Braun 2009; Vondrák 2008). The aim of this paper is to define *Process Framework for Emergency Management*, which allows more effective and complex process support for EM. During the deployment of processes there is also necessary to guarantee their overall quality (Jain and McLean 2003). Hence the paper describes methods to assure quality of processes, i.e. verification and validation (Sargent 2005). Continuous improvement of processes by process optimization is also very important (Rüppel and Wagenknecht 2007). Practical use of the Process framework, together with methods of process quality assurance is illustrated on the case study that describes an accident of a vehicle transporting dangerous goods.

PROCESS FRAMEWORK FOR EMERGENCY MANAGEMENT

Process Framework for EM is a new progressive view on process support of organizations in the private and public sector. It is created for the purpose of better understanding of issues that are connected with process deployment in the specific area of interest. The model covers not only process related issues, but also issues related to emergency management. Deep analysis of current solutions and approaches (Diehl et al. 2006; Klopfer and Kanellopoulos 2008; Sell and Braun, 2009) shows, that just this unifying view on process deployment is missing. Despite the fact, that the model is focused on the emergency area issues, the idea of creating a process framework is general and could be used also in other areas of expertise, where a complex and global view on the area of interest is needed. The general purpose of the model is given by two main views on the process issues, which are *Methodology* view and the global *Architecture* view.

Methodology

The first view is created by process oriented methodology. The main goal is to continuously improve process, which is the same idea as Deming cycle. This view is based on the Business Process Management life-cycle (Weske 2007). In order to talk about process-oriented methodology, it is necessary to meet certain characteristics. The methodology consists of five basic phases, where every phase is further process decomposed. Namely there are these phases: *Defining*, *Modelling*, *Configuration*, *Execution/Monitoring*, and *Optimization*. The methodology contains user roles, which are necessary for correct progress of the process and the roles show responsibilities for the particular processes (Ludík and Ráček 2008). The roles are not just the ones focused on the ICT view of process deployment, as is the role of Analyst, Designer and Tester, but there are also roles for emergency management. Namely it is Intervention Commander, Operator of the Regional Operating Centre and last but not least specific Rescue Units. The next essential part of created methodology are individual work products, either input or output. Some of these artefacts are included into the process framework. There are primary phases like Defining, Modelling, Configuration and Monitoring. Executing and Optimization phases are described from a different point of view. Process execution is analysed from the view of tools that are needed for execution of modelled process instances. On the other hand the optimization phase is focused on techniques and options of process reengineering. The Fig. 1 shows on the left side the general process oriented methodology.

Architecture

The second part of the process model is created by process oriented architecture. It is based on WfMC

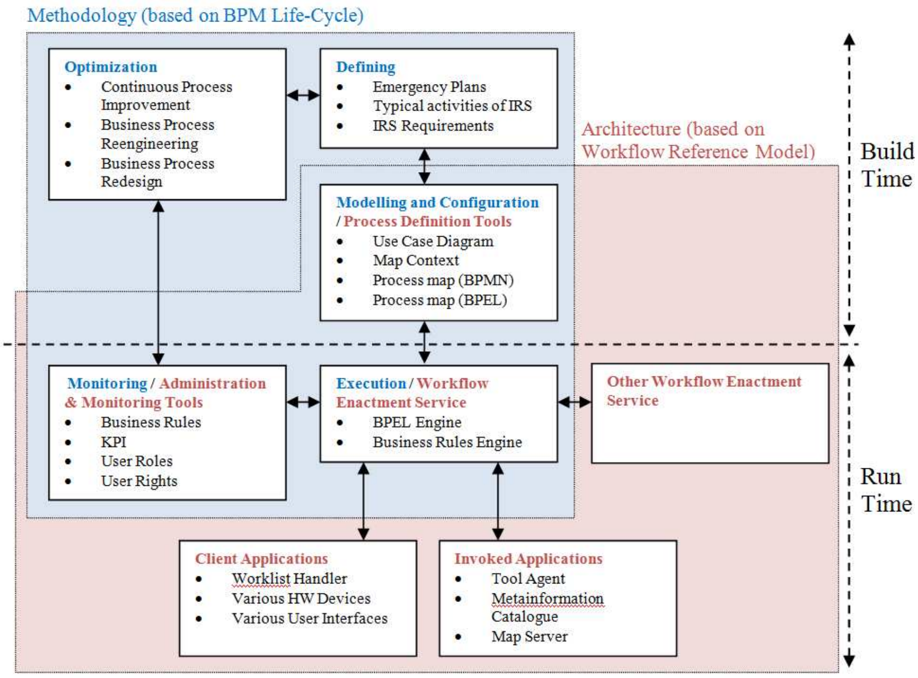

Figure 1: Process Framework for Emergency Management

principles and primarily focused on software tools required for process deployment into organisations. The major task is to define suitable interfaces for communication among individual components of architecture (Hollingsworth 2004). The architecture view is situated on the right side of the process framework. The main parts of the system are described from the view of software tools or hardware components use. Particularly that are parts like Workflow enchantment service, Client Application and Invoked application. The view is completed with issues of emergency management and because of this the model contains also components like Map Server, Metainformation Catalogue and various hardware devices or user interfaces that are necessary to manage specific crisis situations (Kozel 2007). The architecture view guarantees that outputs from individual phases of the methodology meet certain criteria and standards to use them in the next phase. The aim of the view is to create a global architecture that will serve as the essentials for modelled process instances deployment so that these instances could cooperate with other services and tools within clearly defined interfaces. Particular example of the architecture is shown on the Case Study (Fig. 4).

Unifying View

The Fig. 1 shows, that each of this two views covers another part of the spectrum needed for depth process analysis used in the emergency management. In some parts of the model there should be given more emphasis on the procedures and defined processes arising from the legislation and methodologies related to crisis management (Optimization and Defining). The process' architecture and clearly defined interfaces among the components are important to enable fast and effective communication among them (Client Applications, Invoked Applications, Other Workflow Enactment Service). The created process framework for emergency management contains also parts, where the methodology and architecture views overlap. In these parts, both views have to be taken into account to better understand the research issues. Especially it is very important in the Modelling phase of the methodology to determine how the modelling process will proceed and what are the specifics, keeping in mind that the resulting processes should be efficient, transparent, and also in the future simply sustainable (Řepa 2007). On the other hand, software tools are also very important. It is necessary that the modelled processes could be easily readable for ICT users as well as for crisis managers. The main advantage of this approach is independence on particular software modelling tools. It is often necessary to use various software tools and combine them, whether for modelling, simulation or even possible optimization (Kubíček et al. 2010). It is obvious that the resulting interoperability between used tools plays a key role.

QUALITY ASSURANCE OF BUSINESS PROCESS

The Process Framework for Emergency Management provides guidance on how the processes can be effectively deployed in the field of emergency management. Application of the process framework shows that ensuring the overall quality of the modelled processes must be an integral part of the framework. For this purpose, the techniques of verification, validation, and optimization of the processes are used as well as case studies in the real environment. The verification process allows checking the output of the individual process framework phases and validation allows checking the completed automated processes in regard to customer's needs and requirements (Reijers 2003, Sargent 2005). At the same time, continuous improvement of the processes is extremely important because it provides organizations with a significant competitive advantage. Effective solving of emergency situations is critical and therefore it is required to verify the functionality of the automated processes in the case studies.

Verification and Validation

Verification and validation (Sargent 2005) enable continuous monitoring and testing of any software projects. Therefore, it is useful to apply them in the automation of emergency management processes. From the view of the process framework for emergency management it is appropriate to use verification and validation in the first three phases of Process Oriented Methodology. The phases are called: *Defining*, *Modelling* and *Configuration* (see Fig. 2).
The base of successful information system design is to understand customer's needs and requirements which are analysed in the Defining phase. This is a challenging process since the customers are not often able to specify clearly their needs. The result of this phase is a list of business requirements the new system has to meet. The list contains identified *production*, *supporting* and *managerial processes*. The identified processes are essential for the subsequent phases. It is necessary to verify whether the final list of requirements is in accordance with the relevant legislation and the organisation policies. Subsequently, it is appropriate to validate the requirements by the customer.
The following phase is modelling. Its aim is to model the identified processes to meet the costumer's demands. The output of this phase are complex process diagrams suitable for subsequent automation. The modelled processes need to be verified whether they meet the business requirements. Validation of this phase represents the customer's approval of the processes. Verification and validation is done by the process simulation techniques. These techniques detect possible defects or bottlenecks in the modelled processes and also illustrate the flow of business processes to the customer (Reijers 2003).
It is appropriate to use verification and validation techniques also in the Configuration phase. The output of this phase are automated processes that can be deployed to the Workflow Enactment Service. Testing and verification check the functionality of the automated process with regard to the process models. The customer verifies the functionality of created process-oriented system and this validation is critical for this phase. The validated system can be then deployed into business environment.

Optimization

To keep the competitive advantage it is not enough to deploy business processes but also to monitor and optimize them continuously. Process optimization is a discipline of adjusting a process so as to optimize some specified set of parameters without violating any constraints. The most common goals are minimizing costs and maximizing throughput and efficiency. This leads to a long-term sustainability. Continuous improvement is therefore crucial. Processes can be improved not only in the *Optimization* phase but also in the *Defining*, *Modelling* or *Monitoring phase* (Fig. 2).
The first process improvement is possible in the *Defining phase*. Customer describes the current processes ("as-is" processes) in the company to a business analyst. Some of the processes can be improved at this stage. Process automation gives space to a better process specification ("to-be" processes). It is not easy to change company processes, therefore it is necessary to get an external examination of the suggested changes by a member of the organization management who is not part of the project team.
The *Modelling phase* is the next stage where it is appropriate to optimize processes. Simulation is one of the techniques suitable for redesign support. The simulation of business processes helps to understand, analyse and design of processes. The designed and redesigned processes can be evaluated and compared during a simulation. The process simulation allows us to detect defects of proposed processes before they are deployed into real working environment (Vondrák et al. 2008). The optimized process is automated and deployed on a process engine.
Monitoring phase follows. Information about individual

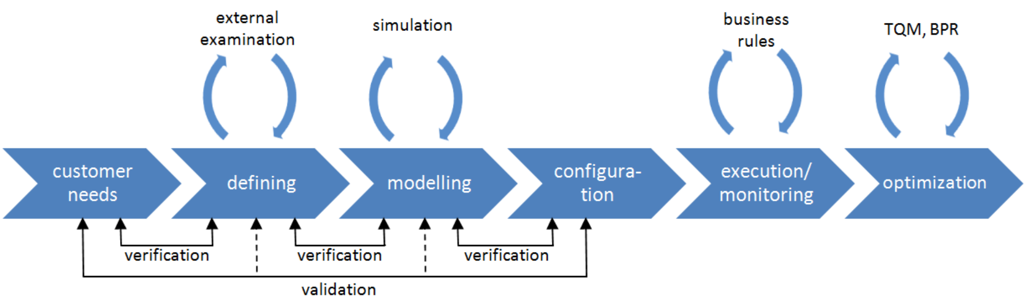

Figure 2: Quality Assurance of Business Process

process instances is collected during this phase. It is possible to monitor progress and performance of individual process instances via the Key Performance Indicators (KPI). In this phase the process can be optimized by business rules which allow better reflection of the real world conditions (Mak et al. 1999). Another possibility to improve the running process is the modification of users' roles and rights.

The last phase of process framework is *Optimization*. This phase is suitable for comprehensive changes in business processes. These changes are supported by detailed analysis of data gathered during the monitoring of process instances. Statistical methods or process mining techniques are used for this purpose. Based on the obtained results, *continuous* or *radical* process improvement can be applied. Continuous improvement is represented by the *Total Quality Management* and radical improvement by the *Business Process Reengineering* (Davenport 1993).

CASE STUDY

This paper focuses on the tactical level of cooperation – activity of the intervention commander and decision-making support during the organisation of intervention in the model situation called *Accident of a vehicle transporting dangerous goods*. The principal aim of this research is a cross-connection of process modelling and adaptive visualisation in the field of emergency management. The proposed solution is targeted on support of the intervention commander activities during the response phase of the accident of a vehicle with dangerous goods.

Process Support of the Intervention Commander

The event *Accident of a vehicle transporting dangerous goods* can be seen in complex view represented by the UML (Unified Modelling Language) Use Case Diagram. It is a basic view of the *defining phase of process framework*. The main purpose of the Use Case Diagram is to find and document modelled business requirements. Created diagram is verified and approved by user's validation. Diehl et al. (2006) used UML to model actors and relations between them with respect to 25 disaster management activities as specified in the Netherlands. They described and formalised selected measurements that might be needed if dangerous substances are released in different environmental conditions (air, water, soil, and surface). We are following similar procedure where each Use Case is based on analyses of the EM procedures in the Czech Republic. This model is also applicable for EM in other countries, but other actors and use cases would probably be administered. The border of the modelled system is defined by the Czech Fire and Rescue Act. By analysing the activities within the event, an actor list is created containing different roles that are assigned to persons or subjects that use the modelled system. Having understood the roles of the individual actors, it is possible to start to design the Use Cases. The external review of final Use Cases is necessary.

The Use Case is perceived as the specification of the activities sequence that the system or subsystem can execute through interacting with external actors. Each use case can be specified by a process map (Fiala and Ministr 2007) incorporating and defining the activity sequences in the particular directives (the *modelling phase of process framework*). A process is a set of activities arranged in parts. It creates in a repeatable way required output from one or more inputs. To illustrate a process map, the use case called Organisation of Intervention is elaborated. This directive controlled by the intervention commander consists of ten activities illustrated in the process map in Fig. 3. In this way, the process maps of organisation of intervention are created. Subsequently the modelled processes are simulated. The simulation reveals bottlenecks and inconsistences. Based on the results the processes are optimized.

During the *configuration phase of process framework* all modelled processes (process maps) are transformed to the Business Process Execution Language (BPEL), where the individual process activities are assigned to the required geoinformation. Within the activities of the intervention commander, it is possible to identify specific tasks that are more or less spatially dependent and thus require geoinformation support.

To determine what and how to visualise, it is necessary to decide what parameters will determine the context in which geographic information will be used. In order to simplify the application of process framework for emergency management, the following parameters were selected to define the context: USER – member of Fire Rescue Corps, ACTION – organising of intervention, SITUATION – accident of a vehicle with dangerous goods, DEVICE – TabletPC. Broadly, ACTION and SITUATION determine the knowledge that is needed

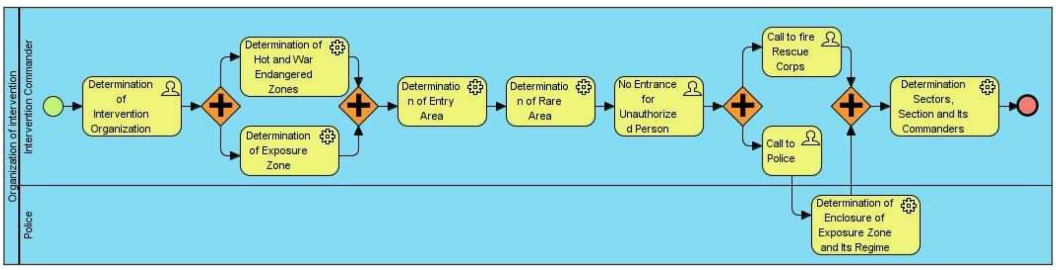

Figure 3: The process map of Organisation of Intervention.

for decision-making and thus what to visualise. USER and DEVICE specify how to visualise this data, i.e. set the visualisation criteria.

The process formalisation in the BPEL form specifies which geoinformation are supposed to be used and finds an appropriate way to visualize them. The so-called context specific map is used for this purpose and is visualised over the background of a topographic base. This BASETOPO is a set of topographic features that can be reused in other contexts. The BASETOPO is defined at several scales – in the application of process framework, the use of BASETOPO in large-to-middle scale is expected.

Terrain Case Studies

The case study was led by the researchers of the research plan Dynamic Geovisualisation in Crises Management and represents business processes deployment and their execution and monitoring according to the process framework. The case study was focused on monitoring processes and testing Contextual Web Map Service (CWMS) and also technologies for vehicle tracking in a real situation (Friedmannová 2010; Kozel 2007), namely during a response phase of a crisis since the main scope of the CWMS (and CWMS client) is to provide support at the time when a disaster is happening.

During the case study the CWMS client was deployed into the complex system that provided support for a fast response to a crisis situation (Palas 2010). The system is showed in Fig. 4.

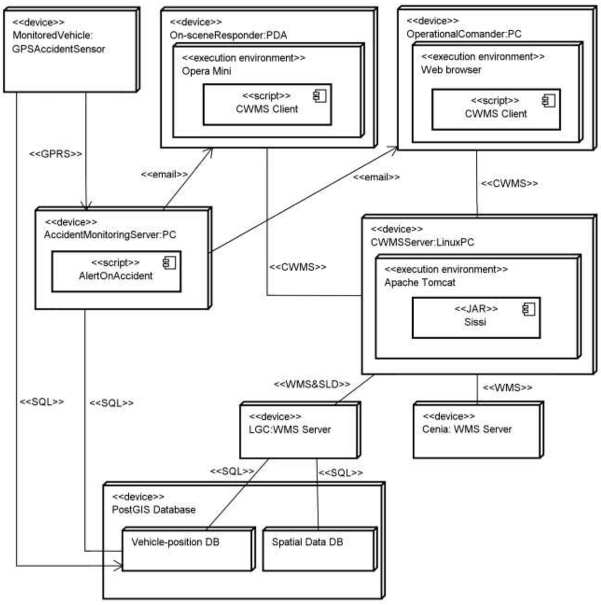

Figure 4: Deployment of the CWMS Client

Each vehicle transporting dangerous substances carries a GPS receiver with an accident sensor and a GPRS transmitter. All the time the vehicle is moving, it sends its position in regular intervals via GPRS to the database that contains positions of all vehicles. When an accident happens, a signal alerting the accident is sent to the server which handles incoming accident signals. A simple PHP script constantly runs on the server. When a signal of a new accident is received, the script obtains the current position of the crashed vehicle from the vehicle-position database.

Furthermore, the script generates an URL of the CWMS client where location and context of the accident in parameters are encoded. Such a CWMS client's URL is immediately sent to an operational centre of IRS and consequently to on-scene responders for the accident via email.

Having received an email informing about the accident, a man in charge clicks the link and the CWMS client opens up in a web browser, showing the accident in the proper context. Operational commanders in operational centres of IRS are likely to use PCs while on-scene responders are likely to use PDAs.

Regardless of the device, the CWMS client requests deserved map for the current situation from the Map-Server via CWMS. Map-Server immediately requests required spatial data from *Laboratory on Geoinformatics and Cartography (LGC) WMS Server* or *Cenia WMS Server* and builds the deserved contextual map which is sent to the CWMS client afterwards.

Spatial data for contextual maps including positions of tracked vehicles are provided by LGC WMS Server, which obtains them from the PostGIS database via SQL. Cenia WMS Server provides just aerial photos which might be required for several contextual maps. Based on the terrain case study results the complex optimization of the processes according to the process framework is available.

CONCLUSIONS

The paper introduces a completely new perspective for the process analysis and deployment. It integrates the current views of organizations as OMG and WfMC and designs new and innovative Process Framework for EM. A model showed the issue of processes in two perspectives, both in terms of process-oriented methodology and in terms of process architecture. The designed model covers the issues of crisis management, which makes the benefits of bridging the two different views even more transparent. The created model is a supplement with specifics for crisis management and is therefore accessible not only to users of IT but also in crisis management.

The functionality of the Process Framework is guaranteed by continuous verification, validation and optimization of emergency processes. Applicability of the solution is also guaranteed by the terrain case study that simulates the progress of typical activities of IRS that describe the Accident of a vehicle transporting dangerous goods in the real environment.

To complete the Process Framework, it is necessary to create and describe a process-oriented methodology, which will define actions for the support of processes in crisis management. The second part consists of hardware and software analysis. It is also necessary to define interfaces between components. The use of standards in this area considerably eases the demands for interoperability. Functionality and efficiency of established methodology and architecture will be validated by case studies. Up to this point the proposed Process Framework will be considered final and it can be deployed in practice, not only on issues related to crisis management, but also to other specific areas.

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