Knowledge Management Systems on Military Universities

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Abstract: An aim of the paper is to summarize the 10 years' experience gaining from research, development, and operation of knowledge management systems (KMS) that supports the military universities cooperation. The ontology is a core part of the KMS; it is a model the system; the methodology procedure is explained. The analysis of the information sources for the KMS is supported by text-mining software TOVEK. The Topic Maps theory and the tool ATOM is mentioned. KMS MilUNI and CEFME for military universities cooperation are presented, their structure and features are explained, and working experiences from the operating phase are included.

Key words: Knowledge management system, military university, Topic Maps, ontology, ATOM, MilUNI, CEFME

Introduction
The paper expresses 10 years of the continuing author's interest in knowledge management systems (KMS) research, development, and education at the Communication and Information Systems (CIS) Department, University of Defence in Brno, Czech Republic. It was the successful 10 years in which were developed some KMS, especially oriented to military universities (MilUni) cooperation.

After introduction is the literature review, oriented to papers indexed on Web of Knowledge in theme KMS and MilUni; continues the methodology of KMS development; explanation of the Topic Maps (ToMa) theory and description of tool for KMS.

The ontology is the main part of the KMS; it is shown the final set of classes, hierarchies, group trees, and associations. The KMS for MilUni cooperation are presented: MilUNI (Military Universities) and CEFME (Central Europe Forum for Military Education), and are documented experiences from their operating phase. Data for MilUNI and CEFME is integrated from the open sources, mostly university web pages

1. Literature Review
The sources of literature review were articles indexed on Web of Knowledge (WoK) and was chosen, with respect to goals of the paper, in themes: KMS; military universities, and their cooperation.

1.1 Knowledge management systems
A KMS affects most businesses (including military), because knowledge is an important resource and ability to learn is a strategically important capability of enterprises and organizations. Knowledge must be encountered at every level in company or institution; working with knowledge is individual task and depends on quality knowledge management (KM) functions that could bring benefit for enterprise, organization, military unit or university.

The KMS in the paper (Li, Jin & Wang, 2014) is crucial for organization of KM. In order to help the evaluation and selection of KMS from the user's perspective, a new multiple criterion propose decision-making method combining Quality function deployment (QFD) with Technique for order preference by similarity to an ideal solution (TOPSIS) in fuzzy environment. In the method, the customer criteria and system criteria for KMS selection are required. The KMS is mention in an article (Khallilazar & Zanjani, 2016) to identify and weight of key performance indicators of KM in organizations.
The connection between KM and software development is in article (Carreiro, De Vasconcelos, Barão & Rocha, 2016). An aim is to emphasize the effect of KM practices during software development projects. Paper presents an approach to cope with KM and engineering practices across software (SW) development projects. The main goal is to define a road map for representative SW development life cycle tasks during a typical software project development. SW maintainers validate, correct and update knowledge from the previous phases of SW development life cycle through the application of back flushing technique at the SW data warehouse.

KM means the organization, creation, sharing and flow of knowledge within organizations. Knowledge can be shared and reused among involved engineers and experts to improve a construction process and reduce the time and cost of solving problems. Paper (Lin, 2014) proposes a new and practical methodology to capture and represent construction project knowledge by using a Building Information Modelling (BIM) approach. Using BIM approach, users can make visual knowledge management in the 3D Computer-aided Design environment. The study addresses the application of KM in the construction projects and proposes a system for general contractors. By applying the BIM approach, all participants in a project can share and reuse explicit and tacit knowledge through the 3D CAD-based knowledge map.

The close association between KM and Topics Maps (ToMa) describe the article (Fueloep, Kormos, Kovacs & Lenese, 2007.). The role of managerial notes on knowledge sharing: Helping the management of unstructured information by using ToMa. Author defines how managers can organize pieces of unstructured information making it semi structured in order to ease searching and sharing. The timeliness of this subject is well illustrated by the war among the large software vendors like Microsoft, IBM, Novell, and Google for the potential customers with demands for technologies handling unstructured information. Research is showing that ToMa together with the Resource Description Framework (RDF) can provide a foundation for the Semantic Web. They can serve to represent information currently stored as database schemes (relational and object). Where databases only capture the relations between information objects, ToMa also allow these objects to be connect to the various places where they occur.

The engineering of laminated composite structures is a complex task for design engineers and manufacturers, requiring significant management of manufacturing process and materials information. Ontologies are becoming increasingly commonplace for semantically representing knowledge in a formal manner that facilitates sharing of rich information between people and applications. Moreover, ontologies can support first-order logic and reasoning by rule engines that enhance automation. To support the engineering of laminated composite structures, this work developed a novel semantic laminated composites KMS that is based on a suite of ontologies for laminated composites materials and design for manufacturing and their integration into a previously developed engineering design framework. The paper shows the power of integrating relevant domains of the product life cycle, such as design, analysis, manufacturing and materials selection through the engineering case study of a wind turbine blade. The integration reveals a usable product-life-cycle knowledge tool that can facilitate efficient knowledge creation, retrieval and reuse from design inception to manufacturing of the product (Premkumar, Krishnamurty & Wlieden, 2015).

1.2 Military universities and their cooperation

The Military University (MiUni) is in retrieved papers mentioned only in context of education, professional training, and preparation in leadership.

The experiences in English teaching implementing massive open online course (MOOC) are in the paper (Feng, 2015) that is evaluated as most suitable in the MiUni.

The article (Nichev & Petrova, 2015) represents the proficiency of the future logistics officers at Vasil Levski National Military University, which is achieved through training in two specialties: military training. A specific of the officer's military management activities lies in its functional responsibilities.

An aim of the paper (Moscicka & Zwirowicz-Rutkowska, 2016) is to present the concept of the inclusion of soft skills into the course program for creating non-standard IT/GIS solutions. A selection of techniques for soft skill development adjusted to the course goals and intended effects is discussed. The courses are held at the University of Warmia and Mazury in Olsztyn and at the Military University of Technology in Warsaw, Poland. A course program is based on 10 years' experience of the authors' training as well as experience from the scholarship at Stanford University and implementation of the knowledge obtained there in the authors' own courses. The courses include the conceptual basis of design, implementation and application of the spatial information system for users who come from
various disciplines and areas of life. Increasingly, they are the humanists, historians, digital heritage specialists, and people from non-technical areas.

The paper (Atanasova-Krasteva, 2015) presents results of the analysis in education of the professional and social components of leadership style of Bulgarian cadets. The research was conducted in the last three years of training in Vassil Levski National Military University during the annual complex tactical field exercise. Situational leadership theory has been used as a basis of the developed model of the cadet’s leadership building.

In the paper (Ding, Luo & Ju, 2015) is the training model of high-level talents discussed through the cooperation between military and common university. At first, the undergraduates, in the common university, finish the course learning outcomes and obtain the required credits. Then they are sent to the related college or key laboratory in the MilUni and take the graduation thesis experimental. Under the union direction of teachers in military and common university, the undergraduates finish the graduation thesis and defend their dissertations in the common university. The practice shows that the talents own the good scientific research ability and comprehensive qualities.

“Modern higher education management is a multi-functional, multi-factor complex structure, and a wide range of integrated system. Establish effective quality management system is an important guarantee to improve the quality of MilUni teaching. The innovation of the teaching management system needs a new idea for breakthrough of incentives, supervision mechanism and competition mechanism (Zhou, 2016)”.

The paper (Kou, Mao & Zhang, 2015) deals with application of modern scientific management theory in military education and adapts to kinds of research methods such as concept analysis; comparison, investigation, qualitative and quantitative research, to put efforts in evaluation system of Students' Comprehensive Quality in MilUni of science and engineering.

Baltic Defence College (BDC) signed a cooperation agreement with Lithuanian Military Academy, which is an accredited university within the Lithuanian national education system. Officers who are enrolled on this program and who are at the same time selected for the studies at the BDC will be able to continue working towards their academic degree while on the BDC courses (BDC, 2018).

All mentioned case studies, research results; experiences in education, military training or MilUni management practice in this part of paper could be included into the KMS MILUNI and CEFME for MilUni cooperation as a study material or positive/negative examples.

2. Methodology of Research and Development

The methodology of development, and implementation MilUni KMS includes the following phases:

1. Decision about KMS orientation.
2. Collection information sources and their analysis.
3. Ontology development:
   a. Classes and associations scheme;
   b. Assignment properties to classes;
   c. Implementation.
4. Inclusion data into knowledge base.

2.1 Decision about KMS orientation

In choosing of the KMS orientation, we had a choice of two alternatives of solution that offers:

1. A group that creates an ontology based systems on RDF and OWL.

Each group is represented by its own environment, a community of researchers and developers, has free-access components (ontology editor, sample examples, tutorials, and other tools), and is governed by de facto and de jure standards.

The first group is oriented on Artificial Intelligence, is supported by the W3C Consortium (www.W3C.org); developed systems based on Resource Description Framework (RDF) and Web Ontology Language (OWL); a typical ontology editor is Protégé (2018). The second group is oriented on librarianship and text documents, is centered on the Ontopia project (2018) and the typical editor of ontology is Ontopoly.
A choice of our team was focused on Topic Maps (ToMa), because the philosophy is closer to our approach (working with documents). But the quality of SW ATOM, based on ToMa theory, available for creating KMS, contributed most to the decision.

### 2.2 Collection information and their analysis

The information sources were the statutory documents of the MilUni and web pages or conference papers about MilUni goals, study programs, research projects, and other activities. The used SW was TOVEK (2018) a professional SW for analysis of information sources and text mining.

SW TOVEK consists of five modules: Index Manager for indexing of data sources; Tovek Agent for information retrieval; Query Editor for preparation of a complex query; Info Rating for context analysis; Harvester for content analysis. See in Fig. 1 an example of content analysis using module Harvester that depicted relations between words in documents. Other result from analysis of the area of interest is a taxonomy of MilUni functions that is briefly characterizes. The taxonomy, created in SW FreeMind (2018), is a useful source for KMS ontology design; see Fig. 2 (a part of the whole taxonomy).

![Fig. 1: Relations between words](source own)

![Fig. 2: Taxonomy of MilUNI functions](source own)

### 2.3 Ontology development

The ontology development is a core task in process of the KMS preparation. Ontology is a heart of the KMS and from the good ontology is derived a quality KMS, too. Ontology is continuously actualized to meet the changing users' requirements.

a) Classes and associations scheme

The scheme of classes (topics) and associations of ontology is prepared in SW Visual Understanding Environment (VUE, 2018). Fig. 3 depicted only small part (sample) of the scheme for ontology design.
b) Assignment properties to classes

The table of assignment properties to classes is the next source for ontology definition. The Tab. I. presents only a small part (sample) of the whole table.

**Tab. 1: Assignment Properties to Classes** (source own)

<table>
<thead>
<tr>
<th>Property/Class</th>
<th>University</th>
<th>UNI-Part</th>
<th>Person</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Firstname</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surname</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Title</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Address</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>E-mail</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>WWW-page</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Text</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

c) Implementation

Ontology implementation in SW ATOM is a simple task, because results of all preparation steps were successfully finished and offer the completely sufficient basis. Ontology definition is possible in graphic mode, see Fig. 4 that shows a part of ontology structure, or in table mode that means including properties to classes with respect to table of assignment properties to classes (Tab. I.).
3. **The Topic Maps theory and KMS Tool**

The Topic Maps (ToMa) technology is the ISO/IEC 13250:2003 standard, the latest revision was published as ISO/IEC 13250-2:2006. The standard consist of the nine parts: Overview and basic concepts, Data model, Reference model, and Different syntax used for persistence and information exchange like XTOMA (XML Topic Maps), CXTOMA (Canonicalization XTOMA), CTOMA (Compact ToMa Notation), GTOMA (Graphical ToMa Notation).


A ToMa is a standard for the representation and interchange of knowledge, with an emphasis on the find ability of information. ToMa represents information using (see Fig. 5):

- **Topics**, representing any concept, from people, countries, and organizations to software modules, individual files, and events.
- **Associations**, representing hyper graph relationships between topics.
- **Occurrences**, representing information resources relevant to a particular topic.

A topic, in general, can be any "thing", a person, an entity and a concept, anything about which may be asserted by any means whatsoever. Subject is defined as the real world "thing" that the topic itself stands in for. Topic refers to the object or node in the topic map. Topics can be categorized by its type. The relationship between a topic and its type is an example of the class-instance relationship.

Topic is linked to one or more information resources, relevant to the topic. Such information resources are the topic occurrences. Occurrence may be any resource from books about the topic to image, video covering the topic to short comment in discussion about the topic. Occurrences are usually external to topic map, depending on used syntax we can point to resource using URI (Unified Resource Identifier) or by any other means. Occurrence can be specified by its role and role type.

The last fundamental part of the topic map is the topic association. The association declares relationship between two or more topics. Association can have a type, in the same way as the topic or occurrence. In addition, each topic plays role in the association. Roles can be typed as well.

![Fig. 5: Topic Map example (ISO/IEC 13250-2:2006, 2017)](image)

### 3.2 Software ATOM

ATOM is a non-programming web database SW for effective development of powerful web applications. One of the goals and benefits of the ATOM is to support the implementation of KMS. This has necessitated some extensions or specification of the ToMa standard.

A simple set of basic features for ToMa internal occurrences were renamed to a Variant type property. The following data types have been further complemented:

- **Code and Ident** – for identification of the entity.
- **Group Tree** – a simple built-in taxonomy.
- **Selection** – forms a one-level code list, applied cardinality 1: N and M: N.
- **Text** – this feature provides the built-in text editor.
- **Picture, File** – internal storage of images and files.

In the definition of associations was included function Order (Sort) and Hierarchy. The complete ATOM solution includes three layers (environments):
a) ATOM Studio: Ontology Designer, administration …
b) Data Editor: Manipulate data via ontology.
c) User Portal: Approach users to KMS.

4. Ontology of KMS
The content of KMS is defined in ontology, which includes classes with properties, associations among classes, and a set of occurrences meaning content of individual classes of the KMS. The MilUNI ontology contains the following set of classes (only selected subset):

**UNIVERSITY** that constitutes structure of hierarchy
- Military universities in NATO countries
- Other MilUni of EU countries which are not in NATO, and MilUni in Europe (apart from the EU)

**UNIVERSITY-PART** (Organizational units of a university, faculties and departments)

**STUDY PROGRAMME** (university study program)

**ORGANIZATION** (other organizations outside the university)
- Research organizations focusing on military
- International cooperation (such ERASMUS)
- Organizations listed in the CIA World Factbook

**PERSON**
- University staff member, organization member, author of a conference paper, ...

**PROJECT** (for example a research project)

**PRODUCT** (the result of an organization or a person)
- For example Command and Control IS (C2IS)

**CONFERENCE** (specialized/scientific conference)

**COLLECTION** (for example conference proceedings)

**ARTICLE** (for example in conference proceedings)

The full set of classes, hierarchies, groups, and associations is at Fig. 6. From the ontology class is automatically derived a form for including, updating or deleting data in Data Editor, see Fig. 7.

Fig. 6: Ontology of the KMS MilUNI (source own)
Fig 7: Class COLLECTION-Data Editor form *(source own)*

5. **KMS MiUNI and CEFME**

The MiUNI (2013) project resulted in Portal for cooperation support of MiUni and its result is available at http://www.atom.miluni.eu/. The MiUNI goal was to provide a platform for collaboration among MiUni in teaching, research, exchanges of teachers and students, and to support of other activities.

A system contains information about universities, their structure and focus of study, information about the university staff and connections with recorded activities, such as positions held, authorship of publications in conference proceedings and journals, and their participation in projects.

There are information about conferences, proceedings, and conference papers, which enables the partners to study or quote them. It includes information about research activities. The MiUNI contains data from public sources on 120 universities (on which is 93 MiUni) and their 251 organizational parts (faculties, departments). Universities are situated in 92 countries in Europe, 19 countries in Asia, and 5 countries in America and Australia.

The system contains a powerful full text search engine and it integrates the information about objects and with the GIS information. The MiUNI portal consists of the three types of pages:

1. The Homepage, see Fig. 8.
2. The search result list, see Fig. 9 (set of conferences).
3. The detail page, see Fig. 10.
The MilUNI was a source for portal CEFME (2015), accessible on http://beta.cefme.eu/. The CEFME (Central Europe Forum for Military Education) group includes military universities from Austria, Croatia, Czech Republic, Estonia, Hungary, Poland, Romania, Serbia, Slovakia, and Slovenia.

A goal of the CEFME portal is to support education and training of military professionals and cooperation of the participating universities in teaching, research, exchange of teachers and students to increase mutual awareness and facilitate the organization of joint events.
A portal CEFME helps in cooperation among other communities of interest, for example LoD7 (working group established in 2009 by the Secretariat of European Security and Defence College to control the international project "Exchanges of young officers, inspired by Erasmus") and iMAF (International Military Academic Forum).

6. Production Phase of the KMS

MilUNI and CEFME are internet-accessed applications; their processing is fully outsourced by Company AION CS, Zlín (2018). Administration of MilUNI and CEFME is provided by CIS Department of the University of Defence (UoD).

The extra maintenance of CEFME portal is provided by national administrators that support working with the portal at their own university. The cooperation the national and UoD administrators must be ready to help with solution of any problem as soon as possible.

Supporting elements for administrators are integrated in portal home page and are continuously updated. There is a list of addresses of CEFME contact persons and addresses of national administrators, as well as contacts to the research team and supplier organization. Furthermore, there is an overview of the underlying changes in the portal, set of frequently asked questions, and set of prepared queries to the portal with the appropriate answers.

To communicate with the national administrators, the "mailing list" can be used which is based on the registration that ensures automatic messaging and sending alerts of any changes in portal. All the above mentioned support means can be facilitated by the distance administration of the portal and used for effective cooperation between administrators in the maintenance and improvement of the CEFME portal.

7. Conclusion

The aim of the paper is to summarize the 10 years’ experiences gained from research, development, implementation, and production of the KMS, especially MilUNI and CEFME. The article presents relevant basic terms concerning the theoretical part of the ToMa, as well as it describes the practical basis of the knowledge approach with SW ATOM. A key point of the solution is the ontology development, the methodology steps were mentioned; improvement of the methodology is still in focus of the research team. The MilUNI system integrate useful information about military universities and support in international cooperation of universities stuff.
The generally applicable results of the research are in methodology of the KMS development and in experiences with that system implementation and operation. The ontology driven KMS can be used in processes of decision making, information support or in education. The similar solution was prepared in some areas, for example Collection of laws in Czech and Slovak Republic, document management systems, cyber security and information protection. The system based on ATOM software is a really KMS, because collect information in context and support the practical using.

The future team research orientation in KMS is area of cyber defense, a new scientific orientation for the CIS Department of the UoD.

Acknowledgment
This article presents the results of the research activities in projects (MILUNI, 2013) and (CEFME, 2015) containing experiences in analysis, development, implementation, and production phase of KMS. The gain knowledge in KMS was transferred into education process at the University of Defence, Faculty of Military Technology, CIS Department; and at Tomas Bata University in Zlín, Faculty of Management and Economics, Department of Industrial Engineering and Information Systems.

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