Knowledge management in Romanian software development organizations

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Abstract: - The software development process is knowledge-intensive. Knowledge is dynamic and evolves with technology, organizational culture and the changing needs of organization’s software development practices. Although, knowledge management in software engineering is a topic that received a lot of attention from international academicians and practitioners this subject was not so appealing to the Romanian counterparts. In this paper we conduct an investigation for evaluating aspects of knowledge management practice in Romanian software engineering industry and discuss the concepts studied and the major findings.

Key-Words: - Tacit knowledge, Explicit knowledge, Knowledge management, Romanian software engineering.

1 Introduction
Knowledge is the most important value of an organization, influencing its competitiveness. In software development organizations, knowledge management (KM) can be used to capture the knowledge and experience that the employees accumulate during the software development process. KM can help software engineers to improve their efficiency, and managers to capture the domain knowledge that software developers acquire during their work. There is currently a gap in literature concerning the implementation of KM practices or KMS (knowledge management systems) in Romanian software development organizations that we will attempt to reduce by conducting an investigation.

2 Knowledge
Knowledge (K) represents a mix of framed experience, values, contextual information and expert insights that provides a framework for evaluating and incorporating new experiences and information. In organizations, knowledge often becomes embedded, not only in documents and repositories, but also in organizational routines, processes, practices and norms [8]. There are different levels of refinement to the items related to knowledge, the lowest one being data, followed by information, and knowledge at the highest level. Data is essential raw material for the creation of information. Information is data that is organized in a way that makes it useful for an end-user when making decisions. Knowledge is broader than information and data and requires understanding of information. Experience is applied knowledge [21].

Knowledge has many features, attributes, and dimensions. For the purpose of this study we must explain the concept of tacit and explicit knowledge. Explicit knowledge can be expressed in words and numbers and shared in the form of data, scientific formulae, manuals and the like. Explicit knowledge is precisely and formally articulated, although removed from the organizational context of creation or use and can be readily transmitted between individuals [17], [19]. Explicit knowledge plays an increasingly larger role in organizations and many consider it the most important factor of production in a knowledge economy [19]. Tacit knowledge is subconsciously understood and applied, difficult to
express, emerged from direct experience and action, and usually shared through highly interactive conversation and shared experiences. There are two dimensions to tacit knowledge. The first is the technical dimension, which encompasses the kind of informal personal skills or crafts often referred to as “know-how”. The second is the cognitive dimension. It consists of beliefs, ideals, values and mental models which are deeply ingrained in us and which we often take for granted. While difficult to articulate, this cognitive dimension of tacit knowledge shapes the way we perceive the world [17].

As a human and knowledge-intensive work [3], the software development process involves both explicit and tacit knowledge. In the context of software development explicit knowledge includes software engineering (SE) methods, document templates, components, software artefacts, and so on, while tacit knowledge is embedded in an individual experience obtained through discussions and lessons learned [2]. Software engineering knowledge is dynamic and evolves with technology, organizational culture and the changing needs of organization’s software development practices [21]. After an extensive research, Bjørnson and Dingsøyr concluded that the major finding on knowledge management in software engineering which is repeated over several papers and across several schools is the need to not focus exclusively on explicit knowledge but also on tacit knowledge [4].

3 KM in software development organizations
Software engineering involves a multitude of knowledge-intensive tasks: analyzing user requirements for new software systems, identifying and applying best software development practices, collecting experience about project planning and risk management, and many others [3]. Knowledge in software engineering context is managed both using the codification approach (focuses on amalgamating individual knowledge in organizations, putting it in a cohesive context and making it available to organizational members) and the personalization approach (knowledge sharing is fostered through people-to-people interactions and dialogue) [9]. In software engineering, reusing life cycle experience, processes and products for software development is often referred to as having an “Experience Factory” [2]. In this framework, experience is collected from software development projects, and are packaged and stored in an experience base. By packing, we mean generalizing, tailoring, and formalizing experience so that it is easy to reuse [4]. In contrast to this codification approach, wherein a central repository of knowledge is offered, is the personalization approach in which knowledge sharing between individuals is realized in an ad-hoc or organized manner. An efficient knowledge management approach (in software development organizations) must be able to model, capture and support the creation and use of both explicit and tacit knowledge [18]. Corbin et al. stated that are several misconceptions about KM in SE and that in order to have an effective knowledge management, it is necessary to adopt a systematic scheme of planning, stipulating, and distributing the knowledge management tasks and activities. They presented a three-tier approach that treats the people and SE process as central pieces of the KM effort [6]. Also, researchers studied the role of KM in software development process and suggested that KM can be conceptualized as a major component of Software Process Improvement (SPI) initiatives [16] or argued that KM in SE assists software developers in defining software processes, pursuing a process-oriented approach and improving and adapting existing software processes for future use [14]. Other several studies were focused on the application of KM in software engineering organizations [12], [11], [15] and have revealed favourable views of existing KM models and frameworks specifically developed for SE, while others showed a negative view towards KM in SE organizations [20].

4 Research
In this study, we used a KM model to investigate the KM process for SE in Romanian organizations, developed by Aurum et al. [1] based on the SECI model (socialization, externalization, combination, internalization), the Experience Factory model and a third model developed by American Productivity & Quality Centre and Arthur Andersen. This integrated KM framework presents a list of major KM enablers, KM process activities and corresponding KMS (as presented in Table 1).

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<th>KM enabler</th>
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<td>Culture</td>
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respondents were asked to:

- identify: the current state of practices for KM in SE, the KM activities that comprise the KM process for SE and the level of impact of leadership, technology, culture and measurement as enablers of the KM process for SE. Data collection for this research was conducted via interviews among the employees of the selected organizations. In order to establish the current state of practices for KM in SE the employees were asked to define the concept of knowledge, to explain what they understand by knowledge management, to express which is their motivation for sharing knowledge and to present knowledge and how they think this problem should be addressed;
- describe what are the activities they perform that are leading towards the development of tacit knowledge and how they think this problem should be addressed;
- rate the level of effort invested on KM activities in the projects they were involved in by assigning a percentage to each activity in relation to the total effort for KM in SE.

To determine the level of impact of the KM enablers the employees responded to a set of questions in which they rated the importance of each enabler of the KM process for SE using a Likert scale.

5 Research results

5.1 Current status of KM practices application

The research results showed many similarities in the current state for KM in SE in both Romanian organizations. The employees of both companies were aware that KM would ultimately improve the quality of the work they produced. Still, not all participants fully understand the concept of knowledge. Several employees from both organizations did not make a clear distinction between the concept of information and knowledge. In both organizations, most respondents claimed that their primary motivation for sharing knowledge with other colleagues is the need for them to perform at the same level in order to be able to finish the projects at the previous established term. Although this is a common answer, several employees motivated that they are reluctant to share knowledge with their colleagues and their motivation was the fear of being known as an expert. They argued that because of this stereotype too much of their work time is allocated to teach other colleagues or that they are assigned to projects according to their past experience. Since the SE is a continuously evolving field they fear that in this way they will not have enough time to allocate to the new developments and experimenting and that this will affect their carriers. In contrast, other employees stated that they are afraid to lose the expert status because they will become expendable as soon as their employers have captured all of the knowledge they need.

The employees of the first company were motivated to extract knowledge from the current projects they were involved in and to formalize it in an explicit manner. They concentrated their efforts on organizing their knowledge for future work, but they used an inappropriate knowledge storage tool that according to them was not very easy to use or as helpful as it should be. The participants from the second company stated that they did not use any tools for knowledge storing. Also, they stated that their colleagues form the main knowledge source and that they usually transfer knowledge using email and instant messaging tools or while engaging themselves in coffee breaks. Both organizations employees stated that they also use other sources of

| K transfer | Training |
| Groupware |
| K application | New IT |
| K adoption | New products and services |
| New markets |

Table 1 The integrated KM framework [1]. According to Aurum et al., this model allows an analysis of various aspects of both organizational learning and effectiveness of knowledge workers that use various technologies and under different cultural environments and leadership styles [1]. The primary objective of this study is to provide a description of the KM process as applied by a sample of Romanian organizations engaged in software development. As far as the authors are aware no empirical investigation has been conducted by Romanian SE industry or other Romanian institutions for evaluating aspects of KM practice in Romanian SE organizations. In this research we have selected two industry-based Romanian organizations that claimed to engage themselves in KM practices. The research objectives are to identify: the current state of practices for KM in SE, the KM activities that comprise the KM process for SE and the level of impact of leadership, technology, culture and measurement as enablers of the KM process for SE. Data collection for this research was conducted via interviews among the employees of the selected organizations. In order to establish the current state of practices for KM in SE the employees were asked to define the concept of knowledge, to explain what they understand by knowledge management, to express which is their motivation for sharing knowledge and to present knowledge and how they think this problem should be addressed;
knowledge like Internet and magazines but some of them were concerned with the validity of the knowledge acquired in this manner. We noticed that the second organization’s management was making efforts to promote standards and process methodologies to support the KM activities mainly the knowledge organization activity.

5.2 KM activities examination
Explicit knowledge increases the potential problem-solving ability of a development team and also facilitates decision-making activities during the software development process, through providing the possibility of knowledge transfer and knowledge integration [1]. Because of the two main characteristics presented above that play a significant role in reducing software development challenges [22], we decided to make an evaluation of the level of explicit and tacit knowledge within both organizations that formed the current study foundation. To complete this second objective, the participants were asked to evaluate each KM activity from the framework for every project they were involved in and to state if the KM activity was performed in an explicit manner. We have selected three projects (enterprise resource planning modules) from each organization investigated. As summarized in Figure 1, the evaluation showed that the first organization presents a higher level of KM activities performed in an explicit manner compared to the second organization investigated. Yet, we revealed that in both organizations the knowledge adaptation activity it is not conducted in an explicit manner.

5.3 KM enablers investigation
In this study the participants rated the importance and applicability of each enabler of the KM process. The results are showed in Figure 3 and Figure 4.
leadership and technology are the most important KM enablers in the second organization are culture and leadership.

When rating the level of applicability, leadership and technology have the most significant impact upon KM in SE for the first organization while for the second organization the culture and technology have the most significant impact. Measurement is the KM enabler with the lowest rate of applicability in both organizations, which could indicate that employees do not know proper measures that could help them make a correct evaluation of the knowledge they possess.

![Fig. 4 The average rate of applicability for each KM enabler.](image)

6 Discussion
In summary, findings were similar with previous studies that showed SE knowledge is highly tacit in nature, (much of which cannot be articulated well or be put in explicit format) and highly contextual in nature, which calls for focused applicability [9].

In Romanian organizations knowledge creation and knowledge acquisition are processes that take place usually in team meetings where different new ideas are presented. Knowledge is identified by individuals and then presented and discussed in team meetings. Also, a large percentage of participants need knowledge to be applicable in multiple situations, but as we can see little effort was assigned to knowledge adaptation in all the analyzed projects of both organizations. Although in the first organization the employees had a knowledge storage tool, the results of the study show that they still retained a significant amount of tacit knowledge from projects they had previously worked on. This is indication that either the knowledge storage tool was inappropriate or little effort was made to complete knowledge organization. Knowledge distribution is mainly done at the direct request of colleagues (because that means that the colleagues will help with future work) or management (for reducing the risk of having important knowledge residing in a few individuals only). The considerably amount of effort for knowledge application (as presented in Figure 1) emphasizes the important role this KM activity plays in SE.

In conclusion the knowledge acquisition and organization are the most prominent of all KM activities.

In terms of KM enablers, in both Romanian organizations, the participants considered that management was responsible for defining strategies that link KM and organizational management. Also, some participants manifested a series of doubts concerning the KMS capability of delivering knowledge both generic and specific in an easily accessible format, while others deplore the lack of KMS in their organization. When asked about what has been done in their organization about encouraging knowledge sharing, promoting open climate for the free flow of ideas, the developers stated that a series of meetings and presentation of topic of interest are held frequently in their organizations. Also the developers stated that they would like to receive rewards for these “extra” contributions, while others argued that they do not have enough time to manage their own knowledge and suggested that a KMS that could help them address this problem.

The study also revealed that both companies invested limited resources in developing appropriate measures for evaluating the impact of KM in SE. Developers considered that it is very difficult to evaluate or measure the level of their knowledge since most of that knowledge is tacit. Also even if a considerable effort is to be made in order to convert tacit knowledge in explicit knowledge, they fear that a correct evaluation of person knowledge can not be done just by counting the number of postings in a KMS database or other similar metrics.

7 Conclusions
Although it is based on a limited number of studied organizations and may not reflect the practices of organizations in all Romanian software industry this investigation provides a preliminary understanding of the implementation of KM practices in SE in Romanian organizations. This study shows that the current state of KM practice implementation in Romanian software development organizations is embryonic. Yet we noticed that efforts are made in order overcome this problem.
References:


