Applying Knowledge Management Approach for Software Testing

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Abstract

Software testing involves the process of detecting software discrepancies so that they can be corrected before they are installed into a live environment supporting operational business units. To better support this complex task of software-testing, this study proposes identifying and applying a knowledge management (KM) approach to software testing. Based on literature review, three frameworks are identified, each of which was used in a project based environment. An integrated hybrid KM framework for software testing is developed by incorporating desirable aspects of the first two frameworks into the third one. To assess the effectiveness of the hybrid framework, an empirical study needs to be conducted.

1. Introduction

Software testing involves the process of detecting software discrepancies so that they can be corrected before they are installed into a live environment supporting operational business units. In addition, software-testing requires expertise in technology as well as business units. Therefore, the testing support team in an organization heavily relies on having ready access to business process and system knowledge.

To better support this complex task of software-testing, this study proposes identifying and applying a knowledge management (KM) approach to software testing. There are several KM based frameworks available in the literature. The APQC (American Productivity and Quality Center) KM framework is one of them. This study will identify most widely used and successful KM frameworks for project-based environment in the literature and assess their feasibility and applicability for software testing. If necessary, a hybrid framework based on identified KM frameworks will be developed. The best suited or developed KM framework can help the organization’s software-testing group improve their skills in defining a software-testing process and facilitate the ongoing maintenance and use of a business knowledge repository comprising software test cases.

2. Concepts in knowledge management

2.1. Tacit vs. Explicit Knowledge

There are two main types of knowledge in knowledge management (KM) literature: tacit knowledge and explicit knowledge. Tacit knowledge refers to personal knowledge embedded in individual experience and involving intangible factors such as belief, perspective, and values. This type of knowledge can be considered to be very difficult to transfer. On the other hand, explicit knowledge refers to the one that has already documented and articulated into formal language, and can be much more easily accessible and transferred among individuals. Hence, one of the key functions of a KM strategy is to make tacit knowledge explicit.

2.2. Knowledge Management (KM)

The meaning of the term knowledge management has been debated, defined, and refined repeatedly. According to Awad and Ghazari [2], knowledge management is the process of capturing and making use of an organization’s collective expertise anywhere in the business – on paper, in documents, in databases (called explicit knowledge), or in people’s heads (called tacit knowledge). They also argue that the main component of knowledge management process involves a cycle of exchanging tacit knowledge and converting it to explicit knowledge and then reformulating it through an individual’s experience and other factors (such as belief, perspective, and values) into tacit knowledge.
2.3. Knowledge Conversion and Generation

Nonaka and Takeuchi [6] refer to the cycle of knowledge generation as a cycle or spiral of enlightenment. They propose a model of knowledge creation and transformation, which consists of four types of knowledge conversion between tacit and explicit knowledge. According to their model of knowledge creation and transformation, tacit knowledge is exchanged with tacit knowledge through socialization. Tacit knowledge can be converted to explicit knowledge through externalization where the hidden know-how is expressed and articulated through metaphors, models, concepts, equations and other forms of explanation. Explicit knowledge can be exchanged and developed through communication. Explicit knowledge is converted into tacit knowledge through internalization where individuals absorb it through experience, testing and/or simulating their use of operational knowledge. Hence, these four different types of conversion can promote the generation of important intangible knowledge assets. Nonaka and Teece [7] categorized these knowledge assets into four classes:

1. Experiential - tacit knowledge shared through common experiences comprising skills and know-how of employees, their energy, passion and creative tensions and other culture impacts developed in the workplace.
2. Conceptual - explicit knowledge articulated through images, symbols, and language by product concepts, design and brands.
3. Systematic - systemized explicit knowledge packaged in documentation, specifications and manuals, databases, patents and licenses and other such intellectual property.
4. Routine - tacit knowledge recognized and embedded in actions and practices such as daily operational know-how, organizational culture and routines.

These four categories of knowledge assets can be relatively easily acquired by promoting the aforementioned four type of conversion process.

3. KM Frameworks for project environments

Based on literature review, three frameworks are identified, each of which was used in a project based environment. These frameworks seem to be appropriate to use for software testing projects. Actually, the second and third frameworks were adopted and used for software testing projects.

3.1. A Framework for KM in Project Environments by Pretorius and Steyn

Pretorius and Steyn [9] propose a framework for KM in project environments mainly focusing on two of the four main activities in KM: codification and dissemination of knowledge. Their model is intended for KM within a single project (intra-project) as well as between projects (inter-project) with emphasis on the dissemination of tacit knowledge. This framework includes three characteristics of KM (mechanism, challenges, processes and procedures) as point of reference and matches these characteristics to those of project environments as illustrated in Figure 1.

Pretorius and Steyn [9] claim that knowledge is automatically managed in project environments for some overlapping characteristics of project environments with those of knowledge management. These overlapping characteristics are shown in italics in the frame work in Figure 3. On the other hand, other characteristics of project environments (indicated in bold in the framework in Figure 1) are considered to be deviated from those of knowledge management. As such, these characteristics need to be treated differently.

Key:
1) Italis: Project management overlaps with knowledge management
2) Boldface: Areas of concern in project management

Figure 1. A Framework for KM in Project Environments by Pretorius and Steyn

3.2. A Framework for KM in Professional Organizations by Kerkhof et al.

Kerkhof et al [4] propose a framework of KM that considers knowledge processes as competencies. They argue that competencies should be understood as
permanent organizational abilities that can be supported in various ways. Their framework is based on the notion of four competencies of the learning organization identified by Sprenger [10]: absorption, diffusion, generation and exploitation. This framework for KM is illustrated in Figure 2:

1. **Absorption** involves the process of obtaining new knowledge from the external environment of the organization.
2. **Diffusion** has to do with the distribution of knowledge among the members of the organization.
3. **Generation** is the process of developing new knowledge and making explicit existing tacit knowledge.
4. **Exploitation** is regarded as the commercialization of knowledge

Kerhof et al [4] regard these four competencies as phases in the introduction of KM in the organization by giving priority to the absorption of knowledge and the diffusion among the members of the professional organizations. In addition, this framework is claimed to reflect the notion of single-loop, double-loop, and deuteron learning by Argyris and Schon [1]. Kerhof et al [4] argue that the phases of absorption and diffusion are processes of corrective learning (single-loop) and the phases of generation and explanations are processes of renewal (double-loop) learning while the introduction of the framework itself into organization can be seen as deuteron learning.

They also include, in their KM framework, three knowledge carriers: people, technical systems, and management systems. In addition, three conditions for KM are added to the framework, based on Davenport et al [3] and Zack [11]: a strategy for KM, the nature of the organization, and the culture of the organization. Finally, methods and techniques for each phase are suggested in Figure 2.

### 3.3. APQC KM Framework

This KM framework for developing KM based processes was jointly developed by American Productivity and Quality Center (APQC) and the Arthur Andersen Global consultancy organization. The APQC claims that this framework clearly illustrates the process steps of a KM process and also the environmental enablers (critical success factors) required for successful transfer of internal knowledge and best practices [8]. There are seven distinct steps in the APQC KM framework as illustrated in Figure 3: sharing, creating, identifying, collecting, adapting, organizing and applying core organizational knowledge assets.

The APQC KM framework also includes four enablers required to promote the development of organizational knowledge: leadership, culture, technology and measurement. These enablers are considered to effective and useful to foster development of organizational knowledge.

These four enablers can be categorized to be “soft enablers” or “hard enablers”. The first two enablers – leadership and culture are deemed as “soft enablers” while the last two enablers – technology and measurement, are regarded as “hard enablers”.

As depicted in Figure 3, the KM process steps combined with the four enablers are considered to be a dynamic system. The APQC believes that this framework supports the management of both tacit and explicit knowledge as follows [5]:

1. **Leadership drivers** – leadership practices encompass broad issues of strategy and how the organization defines its business and uses its knowledge assets to reinforce its core competencies.
2. **Culture drives** – cultural practices reflect how the organization views and facilitates both learning and innovation, including how it encourages employees to build the organizational knowledge base in ways that enhance value for the customer.
3. **Measurement drivers** – Measurement practices include not only how an organizational quantifies its knowledge capital but also how resources are allocate to fuel its growth.
4. **Technology drivers** - Technology practices focus on how an organization equips its members to communicate easily with one another, as well as the systems it uses to collect, store and disseminate information.
4. Discussion

Three frameworks are discussed so far. They have many aspects of KM in common even if each model tries to emphasize certain aspect of KM in project environment. Each framework has some merit (as well as drawbacks) to be used for software testing projects. However, the third framework is regarded as the most comprehensive and complete among the three identified frameworks for the following reasons:

- The first framework addresses only two processes of KM activities, codification and dissemination.
- The second framework uses four competencies of learning organization and reflects the concept of single- and double-loop, but putting the four competencies in one sequence of processes might be problematic in some situations. For example, the diffusion process can take place even after the generation process. In addition, unlike the other two frameworks, this framework has two separate creation processes; absorption and generation.
- The third framework has seven distinct steps and includes four enablers (or critical success factors). Besides, there is a case study that reports that using this KM framework is an effective way for teams or organizations wanting to capture and convey tacit knowledge on software testing, more specifically, regression testing [5].

Yet, the first and second frameworks can be useful for KM in project-based environment considering the merits of these frameworks. The first framework provides a very detailed coverage for the two steps of KM, codification and dissemination in terms of mechanism, challenges, and processes and procedures for these two steps. On the other hand, the second framework was adopted and applied to a case study for software testing, proving potential applicability to KM in software testing projects.

As such, an attempt will be made to incorporate any desirable features of the first and second frameworks into the third framework.

First of all, the mechanisms, challenges, processes and procedures for the steps of codification and dissemination in the first framework will be incorporated into the third framework. However, these two frameworks have different sequence of steps in KM. To correctly handle the incorporation, the following can be done:

1) Insert the step of “Codification” in the first framework between the step of “Create” and the step of “Identify” and then apply the specified mechanisms, challenges, processes and procedures.
2) Apply the specified mechanisms, challenges, processes and procedures for the step of “Dissemination” in the first framework to the step of “Share” in the third framework.

The next step is to try to incorporate some desirable aspects of the second framework into the third. The second framework clearly specifies knowledge carriers as people, management systems, and technical systems, which are not included in the third framework. These knowledge carriers can be include in the third framework, more specifically, in the portion of organizational knowledge. Regarding the conditions (for successful KM) specified in the second model, i.e., a strategy for knowledge management, the nature of organization (willingness to support the different phases of in the knowledge cycle), and the culture of the organizations, the first two conditions can be mapped into the “leadership” enabler as sub-conditions. Alternatively, to be more specific, it is possible to have three enablers or conditions in the framework, “leadership”, a strategy for knowledge management, the nature of organization.

The resulting, integrated framework for KM in project environments (or software testing project environment to be more specific) is illustrated in Figure 4.
5. Conclusion

To better support the complex task of software-testing, this study proposes identifying and applying a knowledge management (KM) approach for software testing. This study aims at identifying KM frameworks suited for software testing environments. From literature review, three KM frameworks for project-based environments are identified and discussed. Out of three identified KM frameworks for project-based environments, the third framework stands out as the most promising framework that can be applied for software testing environments. Desirable features of the other two frameworks are incorporated into the third framework in order to revamp the third framework for enhanced effectiveness and applicability.

As a future study, an empirical study needs to be conducted to assess the feasibility/applicability and effectiveness of the proposed, integrated framework for KM in software testing environments.

6. References


