AN EVALUATION OF A KMS FRAMEWORK FOR AN OPEN SOURCE SOFTWARE DEVELOPMENT IN A COLLABORATIVE ENVIRONMENT

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ABSTRACT: *In the realm of software development, the emerging Open Source Software Development (OSSD) introduces a new concept of software engineering that revolutionizes the process of software development, and also the working culture. Currently, there is a lack of knowledge concerning the appropriate model or architecture to support the development of Knowledge Management Systems (KMSs), especially those supporting collaborative OSSD, which can facilitate knowledge sharing among practitioners. Thus, the researchers undertook a study to investigate current practices and to identify relevant system components that can help conceptualize a sound, viable KMS framework for knowledge sharing in the OSS development. A survey was conducted involving a group of selected OSS developers in Malaysia to elicit feedback on such a framework for collaborative software development and to validate the proposed framework's components. Data gathered were analyzed using the Rasch model and reliability statistical procedure in SPSS. The analysis showed that the Cronbach Alpha's reliability coefficient was .97, suggesting that the research instrument is highly reliable. Overall, this study provides important insights into the formulation of a viable KMS prototype, underpinning by sound theoretical and methodological judgments, to foster a collaborative software development environment. In addition, lessons learned can help create a more supportive, responsible KM society.*

Keywords: Open Source Software Development, Knowledge Management System, Community of Practice, KMS Framework

1. INTRODUCTION

In light of the rapid progress of ICT, the researchers embarked on a study to investigate the effective use of a strategic tool to render a collaborative environment for software development. The development of this tool was carried out through the Open Source Software Development (OSSD) that seamlessly combined both Open Source Software (OSS) and Knowledge Management (KM). Interestingly, the availability of Free/Open Source Software (FOSS) and Knowledge Management System (KMS) adds a new paradigm in developing novel tool in sharing and disseminating information and knowledge. In fact, these two technologies have been introduced several decades ago in developed countries, but their adoptions in developing countries — notably, in Malaysia — have been a recent event. There are many OSS products freely available to the public, which encompass a diverse range of categories, such as operating systems, web servers, browsers, databases, programming languages, office applications, content management systems, graphic software, and many others. This array of software, which keeps on expanding, is being updated by the special interest groups of the internet communities, which aim to provide free, non-proprietary tools, and applications to the global communities, transcending the financial and geographical barriers.

In the Malaysian context, the adoption of OSS is quite a recent event that is limited to only a handful of IT practitioners. Realizing the immense potentials of this technology, the Malaysian government, particularly through its dedicated agency, the Malaysian Administrative Modernization and Management Planning Unit (MAMPU), has launched a series of initiatives that aim to propel the greater use of the OSS technology. Efforts by the Malaysian government were initially focused on the public sectors, where in 2002 several federal and state agencies have started to adopt the OSS technology in some of their operations. These initiatives were closely monitored under the ambit of MAMPU to ensure the OSS initiatives were implemented according to plan. Later, in 2004, the commitment of the Malaysian government for the greater use of OSS was made more apparent through the publication of its official policy called the *Malaysian Public Sector OSS Master Plan*. The master plan comprises a roadmap that outlines the long-term strategies and milestones in achieving the OSS vision and objectives.

Essentially, there are eight main areas of OSS implementation in the public sector, and one of these is knowledge sharing. This part of the OSS plan that deals with knowledge sharing served as the focus of the study undertaken based on the Open Source Software Development (OSSD). Feller and Fitzgerald [1] strongly argue the importance of OSSD approach in developing effective applications that are reliable, inexpensive, high quality; moreover, such applications can be quickly produced, effectively shortening the lead time. However, they caution that this approach is not totally without any drawbacks, but its advantages far outweigh its disadvantages, thus making its adoption appealing to many software developers. Arguably, the history and nature of the OSS development is quite different from the conventional software engineering methodology. Of late, the former is gaining traction in its adoption, despite the traditional OSS development methodology dominating the realm of software development over the years. Interestingly, OSS development methodology is now making inroads in the development of software engineering projects [2].

Several studies have been carried out to examine the success of the OSS technical implementation of AOS. For example, Abdullah *et. al.*, found that a majority of software developers did not fully utilize OSS tools in software development phases. This study also revealed a more disturbing scenario: The majority of the OSS developers in Malaysia has not fully embraced the core principles of KM practices that stress

on knowledge sharing, which is crucial in the software development phases [3]. The finding was also quite surprising given the current practice in knowledge sharing of OSS development between knowledge providers and knowledge seekers that is mainly based on emails [4]. Moreover, the lack of compliance to a proper methodology further compounds the problem of the open source software development [1, 5, 2]. In this regard, [1] caution the importance in adhering to the best methodology and toolkit to support the FOSS. In addition, [5] raised some probing questions pertinent to the software development techniques that are normally used in FOSS projects, which are informal and self-managed. Likewise, [2] raised several questions regarding the current practices of FOSSD projects that might be applied in the realm of software engineering. In terms of KM technology, [6] argues that the lack of standardized KM methods and techniques is due to their nature that are inherently complex.

In order to solve the problem addressed by [3], a KM technology seems a viable method to share knowledge in OSSD among practitioners [1,5,2,6,4]. However, the adoption of this approach is anticipated to be difficult in view of the lack of appropriate KMS models and architecture to support OSSD in a Collaborative Environment (CE) to provide the knowledge sharing mechanism. Therefore, the solution for this impending problem is to create a sound KMS framework that would lead to an appropriate KM system prototype, which when implemented would enable the CoP to share OSSD knowledge through a collaborative environment.

The remaining part of the paper is structured as follows: Section 2 and Section 3 discuss related works and the research methodology, respectively. Section 4 presents the results and discussion, and finally Section 5 highlights the conclusion of the paper.

2. RELATED WORKS

This study was carried out with the main aim to develop a collaborative OSS development framework based on the combination of OSS and KMS. OSS is defined as software of which the source codes are published and made available to the public, enabling anyone to copy, modify, and redistribute them without incurring any form of royalties or fees, thus ensuring flexible, non-profitable use [7,2].This non-proprietary practice creates software that are inexpensive without compromising the reliability and quality of their performance [1].

Recently, many companies have acknowledged the importance of managing and controlling their knowledge and intellectual capitals [8,9]. For example, [10] define knowledge as "a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experience and information." Knowledge can be categorized into two types, namely explicit and tacit knowledge [11, 12, 13]. Knowledge serves as an important resource that is essential to an organization's ability to innovate, and it is a critical factor affecting an organization's competitive standing in the new global marketplace [14].

Knowledge Management (KM) has rightfully become a focus in many organizations, and KM experts have offered several definitions of Knowledge Management (KM). At the fundamental level, KM refers to the methods and tools for capturing, storing, organizing, and making accessible knowledge and expertise within and across communities [15]. From the organizational perspective, Serban and Luan [16] assert KM as the brain power of an organization that functions in a systematic and organized manner in order to achieve efficiencies, ensure competitive advantage, and spur innovations. On the other hand, Miller [17] and Abdullah [18] contend KM as concept that is concerned with capturing an organization's know-how and know-what, and managing knowledge through knowledge creation or acquisition, storage, dissemination and application.

Similarly, several experts have defined KM as the process of capturing collective expertise and intelligence in an organization and using them to foster innovation through continued organizational learning [19, 20, 8]. Furthermore, Gopal and Gagnon [21] defined KM concept as the necessary identification of knowledge categories as follows: to support a firm's strategy; to evaluate the firm's present state of KM; and to transformation the current knowledge foundation into a new, powerful basis for knowledge that fills in any existing gaps. Seen from another perspective, Bollinger and Smith [13] defined KM as the identification and communication of explicit and tacit knowledge residing within processes, people, products, and services.

Furthermore, Jennex [7] defined KM as the practice of selectively applying knowledge from previous decision-making experiences to current and future decision-making activities with the expressed purpose of improving the organization's effectiveness. The idea of a KM system is to enable employees to have ready access to the organization-based documented facts, sources of information, and solutions. In contrast, DePaula and Fischer's [22]view of KM is different from the traditional perspectives (which consider it only as a commodity), of which KM is perceived as a design-oriented communities concept with a focus to support collaboration communication, and development of social networks (SNs) among the stakeholders in the design activities.

Instituting KM initiatives into companies' plans for higher productivity and business growth has been a common feature of the current trend in adopting knowledge-based solutions that transform these business entities into dynamic, versatile organizations. These efforts are being undertaken as many organizations have now realized the great advantages offered by KM approach: by becoming more effective, where relevant information is readily accessible; and efficient where information is accessed at a faster rate [23]. Similarly, O'Dell, *et. al.,* [24] emphatically argue that KM adoption can help organizations to become more competitive by using new knowledge that reduces costs, increases speed of operations, and vouches for customer needs. Likewise, Wiig [25] has identified two main objectives of KM that can help organizations to remain competitive: enabling the organizations to act as intelligently as possible in order to

secure its viability and overall success; and realizing the best value of its knowledge assets.

Weaving through the many definitions, opinions and concepts offered by the KM experts, it is clear that KM refers to tools and methods for managing knowledge by capturing, disseminating and storing knowledge and other related activities, with the ultimate aim of increasing the worth of companies through savings in terms of time and cost. Of late, the imperative to adopt the KM approach has gain much traction in view of the market forces that are volatile and constantly shifting, which can put a high premium to companies that are not well prepared or well equipped with this know-how.

To promote knowledge sharing in OSSD, KM technology is needed to support the KM process for capturing, storing, organizing, and accessing knowledge and expertise within and across communities [15]. Thus, the researchers proposed a KMS framework for a specific domain of practice, because standardized KM methods and techniques are still not available due to their dynamic, evolving nature [6]. The evaluation of the framework was based on the improvement of KMSOS^{2}oD Framework [26,27].

3. METHODOLOGY

The method used to collect the data was based on a survey, using a questionnaire as the research instrument. The development of the survey questionnaire was based on the proposed KMS framework. This framework helped guide the formulation of the questionnaire items, with each item rated along a 4-point Likert scales, ranging from "1" (*Strongly disagree*) to "4" (*Strongly agree*). In addition, several items were framed based two options: "1" (for *Yes*) and "2" (for *No*).

The purpose of the questionnaire was to validate the framework by eliciting respondents' feedback and opinions of the framework components that support sharing knowledge in OSSD. Specifically, the validation was based on the OSS toolkits User Rating and international standard, the role of collaboration and CoP, and the ability to support software development. To validate the framework, the Delphi technique was used to gather expert opinions from a panel of experts. Using this technique, researchers will be able to obtain relevant, important feedback or opinions from the practitioners [30, 31], which in this case involved a group of experts who had vast experience in IT and OSS.

In this study, the randomized sampling method was used to select the panel of experts. Hundred questionnaires were distributed to the respondents, but only 24 questionnaires were returned. The questionnaire, which consists of four sections, was constructed by taking into account the framework components. Section A addresses the demographic information; Section B deals with the OS infrastructure, Collaboration tools, Technologies, and Repositories; Section C pertains to software development and OSS; and Section D focuses on the CoP, Technological Components and Application.

The survey questionnaires were administered to 24 respondents, who were public servants working as system analysts, programmers, and academicians in Perak, Selangor, Kuala Lumpur, and Putrajaya. They were specifically chosen to be in the survey as they have vast experience in OSSD. The survey data were analyzed using two statistical software , namely WinSteps (Rasch modeling software) and SPSS. Using these two statistical software, reliability and validity test, descriptive analysis, correlation analysis, and factor analysis were performed on the data.

4. RESULT AND DISCUSSION

The reliability testing was performed using the WinSteps and SPSS software. Rasch modeling was carried out in WinSteps to help measure persons and items separately, whereas SPSS was used to measure the overall reliability of the research instrument. The findings of analyses show that the overall reliability, persons reliability, and items reliability are high, as evidenced from the computed coefficients of .97 and .78 respectively, (Refer Fig. 1) Thus, the research instrument is deemed highly reliable and appropriate for such research [28].

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	280.2500	650.9783	25.5143	83

Reliability Coefficients

N of Cases = 24.0 N of Items = 83

Alpha = .9737

Fig (1) reliability

An analysis of the respondents' background was also performed by focusing on gender, age, education, IT experience, OSS experience, and organization. The analysis showed that there were 67% male experts and 33% female experts. Clearly, the former outnumbers the latter, suggesting that male practitioners dominate the IT industry in Malaysia. In terms of job category, those working in the industry were twice the number of those working as academicians. The majority of the former worked as system analysts and programmers.

For those working in the educational sector, respondents who were in the age range of '31-35' and '36-40' equally made up 12.5% of the total academicians (which totals 25.0%). For those working in the public sector, 25% of them were aged between 31 and 35 years, 20.8% were 30 and below, and the remaining 16.7% were aged between 36 and 40 years. Evidently, those with ages between 31 and 35 formed the majority, registering 37.5% of the total respondents. In terms of IT experience, those who had the experience between six and 10 years were the majority, constituting slightly more than half (54.3%) of the total respondents. For the academicians, exactly half (50%) of them had IT experience between 11 and 15 years.

In terms of OSS experience, those who had the experience above seven years were the majority, constituting slightly more than a third (34.8%) of the total respondents. Interestingly, relaxing the experience level to three years and above witnessed the percentage climb to 82.6%. Furthermore, 56.5% of the respondents had relevant experience for more than five years.

The final analysis performed was on the survey data to determine the ratings of the framework components, namely OSS toolkits User Rating and international standard, collaboration, technology and CoP, and software development. The analysis showed that the mean scores of the components ranged from 3.19 (for OS) to 3.55 (for Technology). This finding suggests that the components of the framework are highly regarded by users. The coefficients of reliability of the components ranged from .87 (for Collaboration) to .97 (for CoP), indicating that their reliability is extremely high. Similarly, the analysis yielded a promising finding that showed their reliability ratings ranged from "Good" to "Excellent". Taken together, these findings provide strong evidence that the proposed framework for an open source software development is highly reliable. Table 1 summarizes the findings of the analysis.

Table 1. The mean scores, coefficients of reliability, and reliability ratings of the framework' components

Framework Components	Mean	Coefficient of Reliability	Reliability rating
OS	3.1912	.9622	Excellent
Collaboration	3.5000	.8740	Good
Technology	3.5492	.9374	Very Good
CoP	3.4583	.9654	Excellent
Software Development (Knowledge)	3.5379	.9234	Very Good

Items analysis was also performed on the data, yielding some impressive results. More than 90% of the respondents agreed or strongly agreed that all the components were important elements of the framework. At 92.8%, OS was the component that recorded the lowest percentage. In contrast, at 99.87%, Technology was the component that recorded the highest percentage. Together, the above findings indicate that the proposed framework consists of appropriate, reliable components to support collaborative development of systems. Figure 1 summarizes the above findings of the analysis on the survey data.

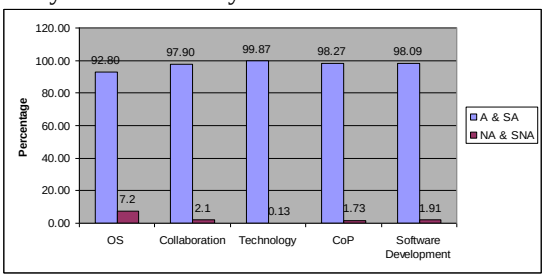

Fig (2) Respondents' feedback of the framework components

5. CONCLUSIONS

The findings of this study show the great potential in developing KM systems that use free, non-proprietary development packages. This study demonstrates that such an approach is not only possible but also practical to be adopted by software development practitioners in the Malaysia. The growth of OSS is gradually flourishing in the world as proprietary development tools are prohibitively expensive than the open source applications. Thus, migrating from the former to the latter would vouch the survival of software development companies, in particular upstart IT players, where production costs need to be controlled and kept at a minimum.

Premised on the promising findings, Malaysian practitioners should reposition their focus by adopting the OSS approach in software development activities. The CoP in Malaysia could utilize the OSS tools and packages in designing and developing their products by instituting the strategy and methodology that have been outlined in this paper. Significant improvements and innovations are within the reach if Malaysian companies start substituting current expensive tools with new, powerful, but low-cost tools as there are several benefits to be accrued as follows:

- Enhancement of knowledge of the CoP in OSSD as many related activities are easily and readily shared,
- Accelerated software development through highly efficient knowledge management system pertaining to specific knowledge domain that fosters appropriate selection and utilization of development tools,
- Huge savings in terms of cost and time, and enhanced skills in software development.

In this study, a framework was conceptualized and developed to support software development methodologies and, in particular, the software development, which consists of five main components, namely layers, functionality, process, knowledge, and CoP. Specifically, the framework was designed to enable CoP to share knowledge in OSSD in a collaborative environment. The conceptualization of the framework was based on the synthesis of the results of a preliminary survey and framework components of six existing frameworks and architectures. The analysis of the survey data yielded several important, promising results where almost all the respondents strongly agreed that the framework components were important and relevant. Thus, these findings strongly suggest that the proposed framework can serve as a reliable tool to help practitioners in OSSD in a collaborative environment

6. REFERANCE

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