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A KNOWLEDGE WORK PRODUCTIVITY CONCEPTUAL MODEL FOR SOFTWARE DEVELOPMENT PROCESS IN SME

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ABSTRACT

The last decade, there has been a growing interest in the knowledge management literature relating to the factors that influence a company's ability to increase productivity. There is a general consensus that knowledge and skills are necessary to develop the capabilities of knowledge workers. However, there is a very little understanding regarding the knowledge work productivity factors as well as their impacts on the quality of the knowledge work productivity in a software development process. The relationships between the knowledge work productivity factors and its quality of knowledge work productivity in small and medium enterprises (SMEs) environment were explored. SMEs were chosen particularly for two main reasons: a SME constitutes a major part of the economy and it has been quite successful in developing quality knowledge work productivity. The knowledge work productivity factors, determined through literature review, were used to develop the knowledge work productivity conceptual model development. Data were collected from 300 respondents representing the SMEs in Malaysia. In addition, the conceptual model was validated using the structural equation modeling. The results do not only provide evidence on the knowledge work productivity factors that are important to the knowledge work productivity and business success but also have implications for both research and practice in SME.

Keywords: knowledge work, productivity, quality of knowledge work, SME.

INTRODUCTION

The establishment of small and medium sized enterprises (SMEs) has given a positive impact in the industrial economy. The impressive business performance in the SME segment will increase the competitive edge of a country and improve productivity (Drucker, 2006). However, the most prominent issue concerning the SMEs is about their survival and growth. In relation to this, a number of researches have been initiated particularly in determining the SMEs knowledge work dimensions. The findings from several of these studies indicated that SMEs are neglecting the issues of knowledge work (Radam et al., 2008). Knowledge work is not only important to understand the business implications, but also to develop the capabilities needed for good performance (Eikebrokk & Olsen, 2007). Unfortunately, there is no published conceptual model work that identifies critical factors for the improvement in the SMEs knowledge work productivity.

A number of researchers have emphasized the important role of knowledge workers in achieving competitive advantage (Drucker, 1999). Majority of these contributions have taken a productivity measurement based on organizational perspective of the firm. Moreover, understanding and leveraging knowledge worker competencies in organizations is essential for developing nations (Drucker, 1999). Knowledge work and knowledge worker productivity will increasingly become the key to national prosperity (Min & Changjun, 2011).

Similarly, skill, knowledge, resources and core competencies are also vital elements in assuring successful quality of productivity. In most cases, SMEs have less financial and human resources compared to large enterprises (Radam et al., 2008). The findings of a pilot survey conducted by (Saleh & Ndubisi, 2006) indicated that on 100 Malaysian SMEs indicate several issues that affect the SMEs' productivity such as high labor costs, lack of innovation, low working capital and limited access to financing. In addition, (Bosch-Sijtsema et al., 2009) point out that resource scarcity, lack of information systems (IS) strategic planning and inadequate expertise in IT are among the causes off the greater risks of achieving quality productivity in SMEs. In fact, most of the SMEs failure projects are due to the incorrect requirement specification. Concurrently, most of the software company cannot properly manage the software process and consciously make the mistake after decade (White, 2013).

There are various definitions of knowledge work. Nevertheless, those definitions usually reflect the following related terms such as knowledge, specialized skill, competencies, and value. In this study, a relatively broad definition of knowledge work as defined by (Ware & Grantham, 2007) is adopted, "knowledge work refers to any activity that requires specialized skill or knowledge or creates new knowledge". The creative processes are inherently important. Knowledge worker for some reason, probably uses existing knowledge or information to create value (Ware & Grantham, 2007). Knowledge work activities, mostly consist of planning, acquiring, searching, analyzing, organizing, storing, programming, distributing, marketing, decision-making, and many other tasks that require the transformation of information from one form to another to produce the final product (Ware & Grantham, 2007).

Productivity of knowledge work is mainly concerned with the quality aspect rather than quantity, which focuses on the quality of work (Drucker, 1999) on the results of knowledge works (Sebastian Eschenbach, Doris Riedl, 2006). In the broad view of knowledge,

knowledge work productivity is considered as complementary to the quality management process in order to improve performance as well as the improvement of the quality standards (Sebastian Eschenbach, Doris Riedl, 2006). Thus, the increasing enhancement of the quality of knowledge works is necessarily important for the quality process.

The challenge to improve performance has intensified the struggle to manage the quality. Increasing high competition, the expansion of international trade and globalization has prompted many companies to concentrate on the quality in the workplace. Traditionally, most organizations try to adopt quality management and performance improvement instrument as a way to innovate and meet customer needs (Flynn et al., 1994). Furthermore, according to the author (Juran, 2004) and (Akdere, 2009) state that integrated quality management approach is to achieve and maintain high quality production, with a focus on the maintenance and continuous improvement of processes and prevention of disability at all levels and in all functions of the organization.

There are various definitions for SMEs. Among the criteria by measuring the number of employees and turnover industry. The EU has given different definitions: Independent company of size less way for the 250 employees and assets below $ 40 million or 27 million euro. SME definition was modified and adopted by member countries with the most and some non-EU countries.

The research question addressed in this study is "Which factors of knowledge work are critical for SMEs to realize the potential business value?" In answering this question, the knowledge work factors were synthesized from the previous study. Then, several rounds of interviews with the managers of SMEs were conducted to verify the factors. Subsequently, these factors were operationalized into a survey instrument. A survey was conducted on 300 SMEs, software developers in Malaysia. Finally, a conceptual model of knowledge work productivity was constructed in order to enhance the quality of knowledge works in assuring business success.

Swarm intelligence in a system of collective agent that interact with the surrounding environment that perform global pattern. This intelligence compose base for the evaluation, comparing and imitation. Swarm intelligence system is act as in their coordinated without external disturbance. In years, the numbers of swarm base optimization is increased such as Particle Swarm Optimization (PSO), Artificial Bee Colony optimization (ABC) and Firefly Algorithm (FA) for robot path planning (Pal and Sharma, 2013).

KNOWLEDGE WORK PRODUCTIVITY

The literature-based analysis indicates that little has been published on the possible relationship between knowledge work productivity and quality of knowledge work productivity in SMEs. In addition, several studies point out the important role of the software developer in order to achieve successful implementation of strategies and technologies. Therefore, in this study, it is hoped that the understanding of knowledge work productivity in SMEs can be improved using relevant theories and findings.

Knowledge work productivity is a very important asset and mainly concentrate on intangible, which difficult to see and assessed (Davis & Naumman, 1999). Examples of knowledge work intangible factors are effectiveness and communication. In general, the intangible factors are difficult to accurately measure and do not have a good measurement characteristics. Therefore, (Erne 2011) shows that the productivity of knowledge work does not only emphasize on the relationship between the quantity of output to the input but also on certain parameters that indicate the performance of a wide range of industries. These parameters include the quantity and quality of day-to-day work, relationships with different stakeholders' behaviors with respect to business and professional innovations, adherence to professional or organizational standards and skill development of expert. Knowledge work productivity, always take place as quality part in the management process targeting to increase performance for the knowledge worker and achieve performance excellence. Quality of knowledge work particularly important in order to improve the quality of the process.

Quality is defined as "an essential property of the products (goods and services) in which high quality products are those that meet customer needs, do not fail during use, and pose no threat to human well-being" (Juran, 2004). Quality management is concerned with an integrated approach in order to achieve and maintain high quality production, with a focus on the maintenance and continuous improvement of processes and prevention of disability at all levels and in all functions of the organization, to meet or exceed customer expectations (Flynn et al., 1994).

The increased in competition, international trade, and globalization influences multinational companies to focus on the concept of quality in the last few decades. This is seen as a challenge in managing the quality in the workplace in order to improve business performance. Traditionally, business organizations have been using various quality management and performance improvement tools for new innovation in improving the effectiveness, quality, productivity, and performance of the certain elements of the organization, such as employees, organizational structure, management, and technology (Akdere, 2009). Among the business focus areas include the work of knowledge and knowledge management. Based on the changing employee demand skills, attitudes and perceptions of a workplace, the demand on the respective technology applications is increased. The technology applications are required to modify work methods and tools, change authority relations in organizational structure, and improve organizational communications and physical workplace arrangements.

This will ultimately contribute to quality, performance and productivity improvements.

More importantly, companies need to increase their efforts on managing knowledge more than ever especially during turbulence conditions. In the paper of (Amin & Cohendet, 2004) state that "firms will face mounting pressure to explore new knowledge or exploit existing knowledge to become 'learning organizations', to maximize quality of knowledge work such as innovation and creativity, to become light-footed and adaptable". Hence, understanding the relationship knowledge works and productivity will provide professionals also with a venue to argue for the utility of their programs from a quality perspective.

The studies try to validate the point of the quality of knowledge works and its contribution to organizational performance and quality of knowledge work productivity attributed to the way for a convincing argument to make the case for the relationship between the two paradigms of knowledge work and definitely improve productivity.

Effectiveness commonly refers to the quality and usefulness of knowledge work output (Davis and Naumman, 1999). It can be obtained by performing knowledge work at an optimal level and sufficiently well to emphasize creativity and the results are complete and accurate. It is highly dependent on the skills and efficiency of knowledge workers. This improvement was due to the efficiency of information technology can improve the rate of expansion of the scope, depth and completeness of tasks or indirectly to introduce a new method that previously had been produced.

Knowledge work is limited in terms of time, barriers to access knowledge and effort, difficulty of communication among workers and availability to access information relevant to the work and knowledge gained in similar efforts. These barriers can be seen in the organization and structure of the group, changes in the work structure and the technology application. The search for more effective working knowledge necessary to avoid obstacles and knowledge work effort should be intensified in order to be more effective and the company must avoid any problems to extent current methods and technologies.

In the management context decisions must be made effectively and become a priority to effective collective decision in the organizations (Harris, 2010). For example, effective decision making is especially important for teams of knowledge workers considering that decision is often the product of these teams. For example, the effective team decision making is related to knowledge work because it is an output or product resulted from a team effort. Among the major benefits of effective team decision making are reduction of time needed to make decisions and improved decision quality. In contrast, the occurrence of problems can impair the quality of decisions and will increase decision-making time.

Apart from that, (Spinuzzi et al., 2004) state that the communication aspect is the most important aspect of the organization. Introduction to modeling methods, software for analyzing, visualizing and capture knowledge work makes the work more efficient. All projects are depicted visually in Communication Event Models (CEM). It will record all the communication of the event in the project team. Each event in the CEM will be recorded in a database with a variety of methods to get a more precise understanding of the dynamic nature of the project, whether past or future. When CEM for each project individually collected, we can clearly see the pattern for the project which not implemented. As CEMs for individual projects accumulate, a set of patterns of use that cut across projects can be recognized, which will then be captured in another visual format known as a Genre Ecology Model (GEM) (Spinuzzi et al., 2004). The importance of communication is also stated by (McManus & Wood-Harper, 2007) which affected the ability of team members and stakeholders.

Another factor that plays an important role in the current knowledge work environment is technology (Davis & Naumman, 1999). The author (Davenport et al., 1998) have a similar agreement whereby they indicate that in the quality management cycle in the organization, technology has been utilized widely to manage the data and information intensively. Furthermore the individual ability and skill of knowledge work are determined by the appropriate used of information and technology's relation to a better productivity of knowledge work (Davis & Naumman, 1999). Therefore, information technology has become the core means for understanding the structure and function of knowledge work in the betterment of its productivity (Davis & Naumman, 1999). There has been a considerable amount of previous related studies on the tools and technologies of knowledge work. For instance, (Hayman and Elliman, 2000) propose a principle design for the knowledge worker-computer interaction interface, claiming that consideration must be given to the way humans receive and process information. Another example is the development of a new input device by (Plate et al., 2000) that allows knowledge workers to intuitively specify three-dimensional coordination in graphics applications in order to enhance work efficiency. In paper of (Changjun, and Zhenyi, 2006) has introduced the proceduralizing and standardizing of tasks. With regard to the human-information interaction efficiency during the knowledge work process, (Liao & Yi, 2010) put forward that when human, information and tasks matched with each other, the human-information system (H-IS) interaction efficiency could be enhanced. In addition, (Liao & Yi, 2010) are concerned about the relationship between knowledge work efficiency and its influencing factors under dynamic work environment without focusing on the exact mechanism of knowledge work. The author (Dan, 2011) pointed out that in order to further increase productivity; information technology has become the core means for understanding the structure and function of knowledge work.

Knowledge work is commonly about performing complex activities through cooperation and collaboration with other people working in teams rather than on individual task which cannot be done alone (Han & Williams, 2008), (Pyöriä 2005). Teams have been viewed as knowledge of integrating mechanism since through

teamwork, individuals' knowledge can be shared and made mobile to the other team members (Erhardt, 2010). Most organizations depend on the knowledge works and creativity of their employees. The effect of knowledge and innovation process has been highlighted as a power of intellectual capital, which refers to the ability of reproducing ideas that ignites value. The author (Krishnan & Prabhu, 2002) has mentioned that in software product development, Indian software developers are allowed to unleash their creativity and fulfill the potential for which they are internationally known. They also suggest that within an organization, the top management is urged to create an organizational climate in which honest failures are tolerated, creativity is rewarded and inter-functional and inter-divisional barriers are lowered.

Currently, most of business organizations are facing limited ways to effectively support their knowledge work in term of innovation, which resulted in a disappointing situation whereby the employee works enthusiasm and creativity are diminishing, particularly in knowledge, innovation team with high potential productivity (Xin-miao et al., 2007).

In the literature, it is stated that quality factors related to the knowledge worker productivity can be classified into effectiveness, efficiency, collaboration, performance and innovation. These factors give profound implications on the quality of knowledge work. Based on previous studies, it is also very relevant to the work environment faced by knowledge workers. Concurrently, these productivity factors must be improved in order to enhance the quality of productivity of knowledge work.

Table-1. Knowledge work productivity factors.

Contributing factors	Authors
Effectiveness and efficiency	Harris (2010), Akdere (2009), Davis and Naumman (1999), Davenport and Prusak (1998)
Efficiency	Liao & Yi, (2010), Spinuzzi et al., (2004)
Programmer performance	Erne (2011), Akdere (2009).
Collaboration	Han & Williams (2008); Pyöriä, (2005)
Innovation	Xin-miao et al. (2007)., Changjun and Zhenyi (2006), Krishnan & Prabhu (2002)

Quality of knowledge productivity

Rating system more efficient for knowledge work reflects not only on the speed of finishing of the particular project, but the emphasis on the quality of knowledge work. In paper of (Liao & Yi, 2010) state that three quality aspect of finished task that has to be considered respectively, including value added, accuracy and customer satisfaction.

The author (Orna, 2006) states that the value added comprise of product information can increase the added value or as an agent refused to business value. This will increase the importance of the work of better quality and innovation.

In paper of (Fitzpatrick, 1996) has used the McCall model to elaborate the aspects of accuracy. Accuracy means how far the program can meet user specifications. McCall model explains deeply is the extent to which a program fulfills its specification. It is difficult to pin down the factor of accuracy because of the lack of standard terminology. It is easy to use the term interchangeably with other actors like reliability and integrity.

In the software quality area customer satisfaction will determine the success of a software project. The author (Denning, 1992) has stated that the customer declares satisfaction (or dissatisfaction) with what the software designer has delivered. Simultaneously, it will determine he extent the program been accepted by the customer.

Apart from that consumer loyalty plays a major role in determining the quality of a product. It also will determine the value of the products. At the end customer trust and emotions consider as mediating factors have given significant impact to the customer loyalty (DeWitt et al. 2008).

Table-2. Quality of knowledge work.

Contributing factors	Authors
Value added, accuracy and customer satisfaction	Liao & Yi (2010)
Value added	Orna (2006)
Accuracy	Fitzpatrick (2011)
Customer satisfaction	Denning (1992)
Customer loyalty	DeWitt, Nguyen, & Marshall (2008)

Based on the theoretical analysis that has been completed, we are projecting and proposed a conceptual model that describes the relationship between knowledge work productivity factors and quality of knowledge work productivity.

KNOWLEDGE WORK PRODUCTIVITY

This study proposes a conceptual framework that is formed by five factors, namely effectiveness, efficiency, collaboration, performance and innovation as shown in Figure-1. Effectiveness is one of the key factors that must

be considered as a measurement towards quality improvement in knowledge work. Effectiveness refers to the extent to which objectives are achieved and targeted problem is resolved.

Effectiveness is determined without reference to costs, but more concern on the quality aspect. Technology will enhance the effectiveness and efficiency of knowledge work. Innovation in knowledge work is fundamentally based on new technology. In contrast to effectiveness, efficiency means "doing the thing right" and mainly concerns with the efficient ways of managing resources, eliminating waste and reducing cost. Management has recognized these factors as important part in business process and takes initial step for further improvement in the management task, resources and technology.

Teamwork is the foundation that brings together knowledge, experience and skills of various members of the team to contribute to the development of a new product more effectively than individual team members performing their narrow tasks in support of product development. Collaboration requires effective team work. Trust and respect among the team members become prominent in the team collaboration. The team members must communicate voluntarily and willing to accept some different views of other members. Knowledge work teams become more and more popular in high-tech organizations, obviously in a dynamic business environment.

Performance refers to a great achievement on giving task measured with preset standards of known accuracy, completeness, cost, and speed. In a contract, performance is based on fulfillment of an obligation, which releases the performers from all liability under the contract.

There is no significant different between a programmer performance measurement in knowledge work compared to that in a more traditional setting. However, the success factors of knowledge work are more toward resource orientated. Among the considered measures are results, external key stakeholders or processes that are somewhat similar. In the knowledge work context, the role of employees as the main asset is emphasized. The knowledge worker is made equal to competencies such as knowledge and skills. Finally, innovation is the creation of better products or more efficient processes, services, technologies or ideas accepted by the market, government, and society. It also reflects the creative and novel fashion on a process which regards to the improvement effectiveness and efficiency or marketability.

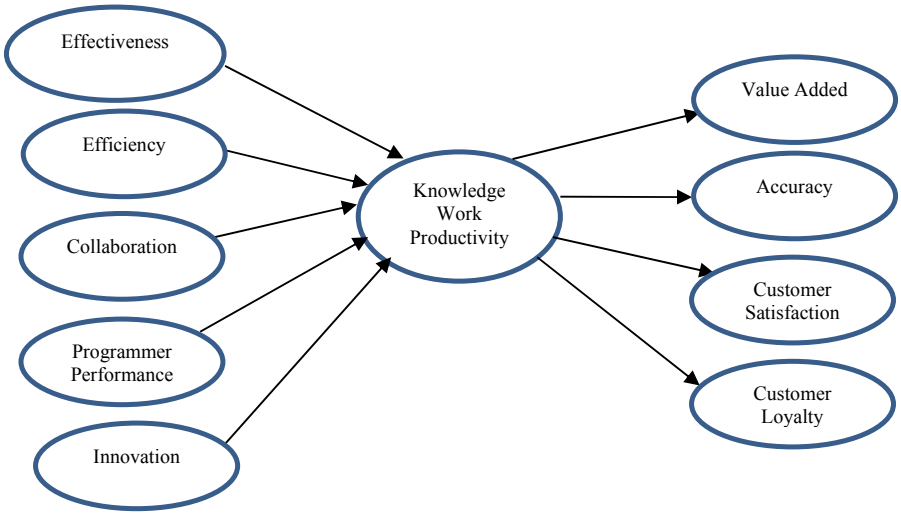

Figure-1. Proposed conceptual model for improving productivity of knowledge work.

METHODOLOGY

The intention of identifying a quality factor of knowledge works is to build a proposed model to describe ways evolving process steps of a knowledge work and knowledge workers can be dynamically organized and coordinate these factors to support various process activities and guide to the process, in an individual basis, to advance process steps towards process completion with higher efficiency and quality. Therefore, it must provide ways to describe diversification of various process. This study will use the four phases of theoretical studies, empirical studies, evaluation and validation framework and methodology in comparative studies.

In the theoretical study, which present the first phase of the methodology, a literature review is conducted to understand the knowledge work productivity model proposed (Davis & Naumman, 1999) and the influencing factors of knowledge work done (Liao & Yi, 2010). Based on this review, the quality factors in knowledge work productivity are identified and proposed as a conceptual model. The second phase is about conducting the

empirical study that involves data collection from SMEs software developers through distributed questionnaires. The sample of this study is 300 respondents who are registered with SME companies. The data are then analyzed by the Structural Equation Modeling by using Partial Least Square Technique (PLS).

The third phase is model evaluation and validation. This phase concentrates on the evaluation and validation of the proposed model using case studies and expert review. The fourth phase is about conducting a comparative study with other works or methods to evaluate The study will take over a period of three months and at least several semi-structured interviews, six meetings overview and particular observations were carried out. Informal meetings are also carried out to briefly explain the theme and concept of the study with selected knowledge workers to determine its reliability.

Data collection

A cross-sectional study of SMEs in the software area was conducted in Peninsular Malaysia. Since the study is part of the software development process under SMEs, the researcher followed the EU definition of SMEs in choosing representable software companies. Any company with less than four employees was excluded.

A random sample of the SME software developers was created from the company databases in Malaysia. Communication through the phone with the selected SMEs was done to confirm on the usage of web pages, e-mail or online systems for research purposes. Those that fulfilled the criteria were then invited to take part in the survey. Each developer for the qualified SME companies would answer the questionnaire through the online survey. It is compulsory for each company to distribute the information through their websites to make sure that other individuals or companies can find information about their products and services.

Data analysis

The SEM is used as the statistical technique in this study because it can analyze all the factors simultaneously. The outcome is significant direct effects of quality factors towards knowledge work productivity. Partial least squares analysis (PLS) is chosen because it is the most appropriate tool to analyze the structure of the proposed model. PLS is based on a confirmatory analysis, second-generation multivariate technique that well suited complex predictive models.

Furthermore, the PLS has several advantages that suit the study capability in handling reflective and formative indicators. At the same, the durability regarding departures from the multivariate normal and the ability to handle multicollinearity in several variables competency of the proposed model made PLS the best choice (Chin, 1998). By using In PLS the predictive ability of constructs must be optimized and the performance of the individual scale items is reported. Measurement models are used to start the reporting of the analysis results.

Formative items represent measures that affect the construct under study. Therefore, any changes in the construct are not expected to cause any changes in the indicators. As a result, the items on the formative scale are not expected to correlate. Convergent and discriminant validity of the test based on the correlation between the items may not be relevant to assess the psychometric characteristics of the formative items. Instead, the weight is used to show how the related items in the measure latent construct.

In general, reflective items that are believed to be caused by latent constructs are intended to measure. Therefore, the intercorrelation among items is expected. Psychometric characteristics of reflective items have been checked by analyzing them in terms of internal consistency, convergent validity, discriminant validity. Convergent validity was estimated by the loading items. A loading above 0.70 is recommended because it shows that at least half of the variance in each case can be explained by the latent constructs.

CONCLUSIONS

This research definitely based on the assumption that knowledge work productivity plays a key role and contribute to the achievement of the organization. Our work aims to identify and examine the relationship between knowledge work dimensions and quality indicators in software development process.

Specifically, both of these two dimensions of the proposed model, namely knowledge of productivity and quality of knowledge work are equally important. This model provides a significant relationship to support for management practices and towards overcoming the challenges of knowledge work productivity within the organization.

Therefore, it is a hoped that this model can be implemented in other working environments to overcome human failure from knowledge work aspect. A further study of the various knowledge work's quality dimensions will be conducted to understand how far the knowledge work will be useful to the developers and organizations

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