A Conceptual Model of Knowledge Work Productivity for Software Development Process: Quality Issues

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ABSTRACT

Knowledge is considered as the main competitive asset of the organization. Work on the knowledge work productivity has barely begun, but the most important contribution that management needs to construct in the 21st century is not only to increase the productivity of knowledge work and knowledge workers in the new century. The quality of knowledge work productivity are becomes pivotal in the context of software development today. Software development is a knowledge-intensive activity and its success depends heavily on the developers' knowledge and experience. A conceptual model will be proposed on a way describing organization to improve quality of knowledge work productivity. The methodology begins with a reviewing a theoretical foundation and expert review that provides the scientific basis for knowledge work productivity specifically for software development. A questionnaire will be constructing in order to investigate the relationship between factors of knowledge work and quality of productivity on knowledge work. The respondents are software developers from Small Manufacturing Enterprise (SME). The data will be analyzed using Structural Equation Modeling (SEM) to identify the significant direct relationship effect among the factors. The proposed model will be helpful for the software developers to understand the determinant factors for knowledge works productivity.

Keywords: Knowledge, knowledge work, knowledge work productivity, quality.

INTRODUCTION

Productivity is the eternal theme of human economic activity; productivity is a never-ending process of exploration. As early as Adam Smith's age, people began to realize the importance of productivity; many of the classical economists researched the productivity problems from different angles. With the coming of knowledge economy era, the knowledge work productivity problem arises gradually, which is regarded as the biggest challenge of the 21st century (Drucker, 1999). The most important contribution management needs to make in the 21st century is similarly to increase the knowledge work productivity. The most valuable assets of a 20th century company were its production equipment. The nature of knowledge work is complex, difficult to be observed and measured (Davis and Naumman, 1999). Even though productivity measurement is absolutely essential to understand and improve knowledge work productivity (Xiao and Dai, 2011). The most important part in knowledge work is to recognize its influencing factor. (Yi and Shu, 2010). The quality aspect plays vital role to determine the productivity of knowledge work (Yi and Shu, 2010). Other researchers (Davenport and Prusak, 2000; Drucker, 1999) stress the important of quality as a factor determining the knowledge work productivity. Knowledge has to be managed in all stages of software development from encapsulation of design requirements to program creation and testing, software installation and maintenance (Desouza, Awazu, & Baloh, 2006).Improving knowledge work productivity, is very important part for the software development and it can be optimized primarily (Davis and Naumman, 1999). It is a widely accepted fact that the quality of the software product is largely determined by the quality of the process used to develop and maintain it (Humphrey, 1989). Thus, for software development process quality is a major factor has to be considering in producing a good quality product.

Literature review indicates in the previous work the concept of knowledge work under quality factors has been put forward but the relationship between knowledge work productivity under quality issues are still not clear.

II PROBLEMS STATEMENT

Since the reforms and rapid development on software industry, there a still lot of issues

growth within software development environment.

Software development processes are facing failure. There are many factors contribute to the failures of the software development project. Human factors are recognizing as a major factor cause these failures. Human factors comprise skill of workers, planning, risk management and teamwork's. The factors likes lack of due diligence at the requirement phase and an important factor the level of skill in design and poor management judgments in selecting software engineers with the right skill sets (McManus & Wood-Harper, 2007). In that way is very difficult to create the process and data model outputs with their reality and practical knowledge of the business process. Weidong, Jixue, & Hawryszkiewycz (2007) mentioned that in order to achieve an outcome, most such processes require participants to have sufficient information and possess a high level of skill and expertise, and also require them to mutually collaborate and cooperate as well. All of these factors are related to quality aspect and effectiveness of knowledge work (Davis and Naumman, 1999).

According to one IDC/Xerox report, for example, knowledge workers spend 15-30% of their time at work conducting searches for information, but up to 50% of these searches are unsuccessful. This sort of failure to understand and leverage regularities in knowledge work can add up to U.S. $2.5-3.5 million annually per 1000 knowledge workers in lost productivity, according to the report. The survey conducted by Standish Group (2007) found that human factors play a significant role in the weakness of projects. This seemed to be a direct relationship between human factors and failure of the projects. A quarter of the benefits of IT projects are being lost by organizations across the globe because of management failures during a project's lifecycle (KPMG, 2010). Whittaker (2011); Verner & Cerpa, (2005) most common reason for project failure was poor project planning in two distinct areas. First, risks were not addressed as part of the project planning process.

McManus & Wood-Harper (2007) found the efficiency; the symptoms of information systems project failure are insufficient communication between the different members of the team working on the project and the end users (stakeholders) and no clear requirements definitions. While communication between team and end users was still perceived as an issue within some projects. Weidong, Jixue & Hawryszkiewycz (2007) pointed out that the knowledge work productivity is one of the key factors that determine enterprise success. Many software projects are behind schedule and over budget, and do not always work as intended. Partly, these failures are due to issues with coordination, communication and knowledge especially which related to the efficiency factors. (Taweel, Delaney, Arvanitis, & Lei, 2009). Based on literature, found that quality issues effectiveness and efficiency are the influence factors of knowledge work productivity and have a significant impact on software development process. These issues' has attracted more attention from international community.

II LITERATURE REVIEW

A Knowledge

Knowledge is the awareness and understanding of facts, truths or information gained in the form of experience or learning or through introspection. Knowledge is the internalization of information, data, and experience. Knowledge is results of learning as stated in (Stulman, 2010). There are two forms of knowledge, tacit knowledge and explicit knowledge. Tacit knowledge is the personal knowledge resident in the mind, behaviour and perceptions of individual members of the organization. Explicit knowledge is the formal, recorded or systematic knowledge in the form of scientific formulae, procedures, rules, organizational archives, principles, etc. and can easily be accessed, transmitted or stored in computers files or hard copy (Mohanta, Kannan and Thooyamani, 2010). Knowledge in the context of software organizations, knowledge is describe as "a fluid mix of framed experience, values, contextual information, and expert insights and grounded intuitions that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of the knower. In software organizations, it often becomes embedded not only in documents or repositories, but also in organizational routines, processes, practices, and norms". (Davenport, 1998).

B Knowledge Work

Knowledge work is the bases of improvement in the knowledge work productivity. Knowledge works is view as an activity that either requires specialized knowledge or skills, or creates new knowledge (Ware and Grantham, 2007).

Knowledge work focuses primarily on creating or applying information or knowledge to create value (Ware and Grantham, 2007). Thomas (2011) stated knowledge work is all work whose output is mainly intangible, whose input is not clearly definable, and that allows a high degree of individual discretion in the task. Changjun and Zhenji (2006) are looking knowledge work from the perspective of improving the knowledge work productivity. They judge whether a work is a knowledge work according the criterion of work procedures and specifications. By definition, some of the tasks for which a knowledge work could be in charge are: planning, acquiring, searching, analyzing, organizing, storing, programming, distributing, marketing, deciding, and numerous other tasks that require transformation of information from one form to another in order to produce the final "product". Knowledge work is usually not an individual task but is performed in cooperation and collaboration with others working in teams on complex tasks, which individuals cannot perform alone (Han & Williams, 2008; Pyöriä, 2005). Teams are view as knowledge integrating mechanism and it is through team work, individuals' knowledge can be shared and mobile in the team (Erhardt, 2011). Improving knowledge works, related to the productivity is vital challenge for the sustainable development and it can be optimized primarily involves the knowledge work Davis and Naumman, 1999). Drucker, (1999): Davenport and Prusak, (2000) stress the important of quality as a factor determining the knowledge work productivity. This also can be important part in software development for improving the knowledge works productivity (Lepasaar & Miikinen, 2002).

C Knowledge Work Productivity

Productivity on knowledge work is mainly concern on intangible aspect rather than tangible aspect on knowledge work. Erne (2011) pointed out that knowledge work productivity should not only emphasized the relation between quantity of output to amount of input however, has to be consider to the specific parameters which indicate expert performance across various industries: quantity and or quality of day-to-day work results, quality of interaction with different stakeholders, innovation behavior with respect to business and or professional innovations, compliance with professional and or organizational standards and skill development in experts. Knowledge work productivity, on the other hand, is considered an integral part of the quality management process to achieve continuous improvement and performance excellence. Its means that the quality improvement on knowledge works is necessarily important in order to improve the quality of process. Quality is defined as "an essential property of 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 however is an integrated approach to achieving and sustaining high quality output, focusing on the maintenance and continuous improvement of processes and defect prevention at all levels and in all functions of the organization, in order to meet or exceed customer expectations (Flynn, Schroeder and Sakakibara ,1994).

The challenge of performance improvement has been intensified with the struggle to manage quality in the workplace. Increased competition, international trade, and globalization have led multinational companies to focus on the concept of quality in the past few decades. Organizations have traditionally adopted quality management and performance improvement tools as a result of their need to reform to improve effectiveness, quality, productivity, and performance of various organizational elements, such as employees, organizational structure, management, and technology (Akdere, 2009). One of the areas of focus of business has become knowledge works and knowledge management (Akdere, 2009). In addition, employees' changing skills, attitudes, and perceptions toward the workplace, increasing demand in technology applications to modify work methods and tools, changing authority relations in organizational structure, and improving organizational communications and physical workplace arrangements have been contributing to organizations' struggle to improve quality and increase productivity and performance. Knowledge work productivity is mainly concern about intangible factors of knowledge works (Davis and Naumman, 1999). Effectiveness and communication are categorized as intangible factors. It means that, it difficult to measures accurately and doesn't have a good measurement characteristics'.

Meanwhile in such tumultuous times, companies need to increase their efforts on managing knowledge more than ever. Amin and Cohendet (2004) argued 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" (p. 1). Understanding the relationship between 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 that have validated the very point of quality of knowledge works and its contribution to organizational performance and quality of productivity undoubtedly paved the way for a convincing argument to make the case for the relationships between the two paradigms knowledge works and productivity improvement. Effectiveness of knowledge work is refers to the quality aspect and usefulness of knowledge work outputs (Davis and Naumman, 1999). It can be achieve by performing knowledge work with more expertise and creativity as well as by achieving more complete and timely results. It certainly depends on skills of knowledge workers. These improvements are manifest in information technologies' that either expand the scope, depth and completeness of activities or provides for the application of new methods that were previously not feasible. Knowledge works has several limits. Time available, constraints on human cognition and effort, difficulty of communication among participants in a project and availability of information relevant to the work and knowledge gained in similar efforts. These constraints can be address by changes in the organizations and group structures, change in the structure of the work and technology. The quest for more effective knowledge work should be constraint to extending existing new method and technologies.

In the management context (Harris, 2010) mentioned that decision making is commonly plays an important role in organizations. One of the key factors for effectiveness team is effective team decision making and it's related to knowledge work. Effective decision making is especially important on teams of knowledge workers considering that decisions are often the product of these teams. The major benefits of effective team decision making are reduction of time needed to make decisions and improved decision quality. Unfortunately, many problems can occur that reduce the quality of decisions and increase decision-making time. Spnuzzi, Davidson and Zachry (2004) stated that communication is important part as a genre in the organization. They introduced a modelling method and software for visualizing, analysing, and enacting knowledge work. All projects are visualized in Communication Event Models (CEM), built from a record of all the communication events that members of a given project team participate in. Each event in a CEM is represented as a database record with multiple attributes that allow for visualizing and sorting the CEM in order to interpret the dynamics of single project in the past or one which is on-going. As CEMs for individual projects accumulate, we can begin to see patterns of use that cut across projects, which we capture in another visual format called a Genre Ecology Model (GEM). McManus & Wood-Harper, (2007) state that communication is one of the important factors influences the ability of team members and stake holders. Technology plays a important role in knowledge works environment today (Davis and Naumman, 1999). Davenport and Prusak (1998) discussed that technology has utilized widely and intensively to manage the data and information which is important part to the entire quality management cycle in organization. Furthermore appropriate of knowledge work information and technologies will determined the individual ability and skill in productivity of knowledge work (Davis and Naumman, 1999). To further increase productivity, information technology has become the core means for understanding the structure and function of knowledge work (Davis and Naumman, 1999). Much of the previous work is related to knowledge work tools and technologies. Hayman and Elliman (2000) proposed a design principle for the knowledge worker-computer interaction interface, claiming that consideration must be given to the way humans receive and process information. Other example, Frohlich and Plate (2000) developed a new input device that allows knowledge workers to intuitively specify three-dimensional coordination in graphics applications so as to enhance the work efficiency. Some requires an innovative approach such as by introducing the proceduralizing and standardizing of the tasks Changjun and Zhenyi (2006). Concerning the human-information interaction efficiency during the knowledge work process, Yi and Shu, (2010) put forward that when human, information and tasks matched with each other, the human-information system (H-IS) interaction efficiency could be enhanced. Yi & Shu (2010) concerns about relationship between knowledge work efficiency and its influencing factors under dynamic work environment without focusing on the exact mechanism of knowledge work. Yang (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. Organization depends on the knowledge works

and creativity of their employees. The impact of knowledge on process innovation was highlighted as the power of intellectual capital is the ability to breed ideas that ignite value. Rishikesha, K. T., & Ganesh, P. N. (2002) stated that in software product development also potentially allows Indian software developers to unleash their creativity and fulfill the potential for which they are internationally known. Within the 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 Rishikesha, K. T., & Ganesh, P. N. (2002). Furthermore at the present the businesses have faced limited of effective way to support knowledge work in term of innovation, which results in disappointing situation that the employee works enthusiasm and creativity are diminishing, particularly in knowledge innovation team with high potential productivity (Li Xin, Shang Qin, & Dong Tian, 2007). It state in literature that quality factors are related to the knowledge work productivity can be classified to the effectiveness, efficiency, collaboration, performance and innovation. These quality factors must be improved in order to enhance the productivity of knowledge work.

Table 1: Knowledge Work Productivity Factors

Authors	Factors Contribute to the knowledge works
Harris (2010), Akdere (2009), Davis and Naumman(1999), Davenport and Prusak (1998)	Effectiveness and Efficiency
Yi & Shu (2010) Spnuzzi, Davidson, and Zachry (2004).	Efficiency
Erne (2011), (Akdere, 2009).	Performance
Han & Williams, (2008); Pyöriä, (2005)	Collaboration
Li Xin, Shang Qin, & Dong Tian, (2007), Changjun and Zhenyi (2006), Rishikesha, K. T., & Ganesh, P. N. (2002),	Innovation

D Quality of Knowledge Work Productivity

The evaluation system for knowledge work reflect not only the speed to finished task but also the quality of the knowledge work productivity. Yi & Shu (2010) has mentioned three quality aspect of finished task that has to be consider respectively are value added, accuracy and customer satisfaction. Orna, 2006 has stated that value add consist of information products have power to add and to subtract business value. Fitzpatrick (2011), using a McCall model briefly explains about accuracy is the extent to which a program fulfils its specification. Accuracy is difficult factor to pin down because of the lack of standard terminology. It is easy to use the term interchangeably with other actors like reliability and integrity.In software quality area customer satisfaction will determined the success of software project. Denning (1992) has state that the customer declares satisfaction (or dissatisfaction) with what the software designer has delivered. Besides that, customer loyalties are considering the factors will determine the valuable quality of the products. At the end customer trust and emotions consider as mediating factors have given a significant impact to the customer loyalty (DeWitt, Nguyen, & **Marshall, 2008).**

Table 2: Quality of Knowledge Work Productivity

Authors	Factors Contribute to the quality of knowledge work productivity
Yi & Shu (2010)	Value added, accuracy and customer satisfaction
Orna (2006)	Value added
Fitzpatrick (2011)	Accuracy
Denning (1992)	Customer Satisfaction
(DeWitt, Nguyen, & Marshall, 2008)	Customer Loyalty

Based on above theoretical analysis, we composed a proposed model for describing the relationship between knowledge work productivity factors and quality of knowledge work productivity was established. Figure 1 depicted of the overall proposed model.

IV A Proposed Conceptual Model

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 major factors that need to be considered and part of the measurement towards quality improvement in

knowledge work productivity. It refers to the degree to which objectives are achieved and the extent to which targeted problems are solved. Effectiveness means "do the right thing" and determined without reference to costs but concern more on quality aspect.Technology will enhance the effectiveness and efficiency of knowledge work. Innovation on knowledge work fundamentally based on new technology. In contrast to effectiveness whereas efficiency means "doing the thing right and it mainly concern to the efficient ways to manage the resources, eliminate waste and reduce cost. Management has recognized this factor as important part in business process and takes initial step for further improvement in management task, resources and technology. Collaboration is the basis for bringing together the knowledge, experience and skills of multiple team members 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. Team members must trust and respect one another. There must be open communication and a willingness to accept input from others. In a dynamic business environment, knowledge work teams become more and more popular within high-tech organizations. Performance means the accomplishment of a given task measured against preset known standards of accuracy, completeness, cost, and speed. In a contract, performance is deemed to be the fulfillment of an obligation, in a manner that releases the performer from all liabilities under the contract. Performance measurement in knowledge work context does not per se differ from using performance measurement in a more traditional setting, but success factors in knowledge work are more resource orientated. The measures considering results, external key stakeholders or processes are somewhat similar. In the knowledge work context, the role of employees as the main asset is emphasized. Knowledge worker equals the competencies, i.e. knowledge and skills. Lastly, innovation is the creation of better or more effective products, processes, services, technologies, or ideas that are accepted by markets, governments, and society. It also reflects to the creative and novel fashion on process which regards to the improvement effectiveness and efficiency or marketability.

V. METHODOLOGY

The intention of identify a quality factors of knowledge works is to build a proposed model for describing ways to evolving process steps of a knowledge work process so that managers or knowledge workers can be dynamically organized and coordinate this 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. Hence, it must provide ways to describe various process activities.

The methodology involves four phases namely theoretical study, empirical study, framework evaluation and validation and a comparative study. In theoretical study, a literature review is conducted to understand the knowledge work productivity model proposed by Davis and Naumman, (1999) and the influencing factors of knowledge work done by Yi and Shu (2010). Based on this review the quality factors on knowledge work productivity are identify and proposed a conceptual model. The second phase is an empirical study that focuses on collecting data from software developers in SME by distributing a set of questionnaires. The sample of this study is 300 as register in SME company. The data will be analyzed using Structural Equation Modeling (SEM). SEM is chosen as statistical technique because it allows the analysis of all the factors simultaneously. The outcome is significant direct effects of quality factors towards knowledge work productivity. The third phase is model evaluation and validation. In this phase, the model will be evaluated and validated using a case study and expert review. The fourth phase is a comparative study with other works or methods to evaluate the knowledge work productivity.

The study took place over a period of four months and fourteen semi-structured interviews, participation in five meeting, and several direct observations were carried out. In order to clarify themes and conceptions the material has been discussed with the knowledge workers in several informal meetings and thus ascertains reliability.

VI DISCUSSION AND CONCLUSION

This paper is based on the assumption that knowledge work productivity is a vital part of organization achievement. Specifically, our work aims to examine the relationship between quality indicators and KWP in SDP. The model shall provide support for management practice and overcome the challenges in organizational knowledge work productivity. Therefore it is a hope that this model can be implemented in other working environment to overcome human failure from KWP aspect. A further study of the various quality factors for KWP will be conducted to understand how far the stored knowledge will be useful to the developers and the organization

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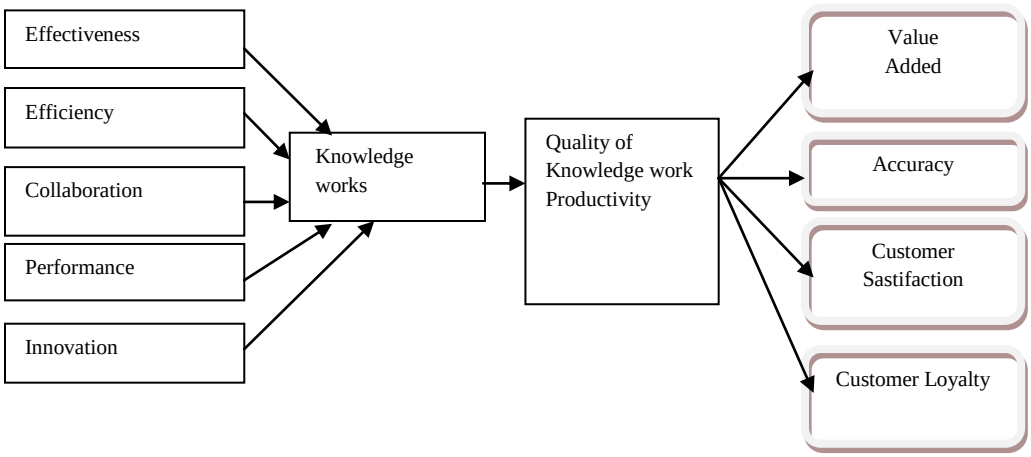

Figure 1: Proposed Conceptual Model for Improvement Productivity of Knowledge Work