Knowledge Work Productivity Measurement for Software Development Process in SMEs

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ABSTRACT

Small and medium-sized enterprises play an important role in the growth of the economy, but most enterprises have failed to develop knowledge work productivity (KWP). The purpose of this study is to discover and propose KWP measurement factors in software development process in small and medium-sized enterprises (SMEs). First, we are making theoretical and prior research progress before the key features of KW and KWP were defined. Secondly, the conceptual model, which explores the relationship between the KW and KWP dimensions, has been built. This research will use the data collected from 150 Malaysian SMEs. Structural equation modelling or SEM was used to validate the model. Based on the results, we propose KWP measurement factors that can help knowledge-based companies, such as SMEs, measure employee productivity.

Keywords: Knowledge work, Knowledge Work Productivity, SMEs.

I   INTRODUCTION

Knowledge work (KW) and knowledge work productivity (KWP) are vital for business success. KW is viewed as capability needed of knowledge worker (Eikebrokk & Olsen, 2007) to become more productive and to achieved that is through to measure KWP and it will become the greatest competitive weapon of today's organizations (Iazzolino & Laise, 2018). Most of the researchers indicated KW is essential to develop the nations (Drucker, 1999; Davenport, Jarvenpaa, & Beers, 1996).

Davenport, Jarvenpaa, & Beers (1996) state that SMEs also must be able to understand and leverage KW of the knowledge workers as the key for the KWP measurement. Several studies have shown that SMEs, not given much attention to the KW and KWP issues as well as quality measurement for the software development process (Drucker, 2006; Min & Changjun, 2011). A pilot survey of 100 SMEs company found several issues regarding KW for example in strategic planning problems information system and lack of innovation strategies (Levy & Powell, 2000). Moreover, most of the failed project are related to SMEs Company attributed to wrong specification requirement in software development process.

Software is becoming pervasive in every business. Many SMEs companies have seen their products and services evolving to become interconnected. (Ponsard & Deprez, 2018). For example, it must offer a digital presence through an e-commerce shop or even develop new digital assets (apps or connected hardware) to support their business. However, developing software is challenging for SMEs, especially to ensure the quality, time, and budget constraints. SMEs differ from larger organizations because of their limited, often less specialized, resources (Mishra & Mishra, 2009). The software development process involves all the stages and activities that are followed by SMEs to develop a software product. Software development is an intensive knowledge process that should be updated, improved and maintained to meet current business and customer requirements (Ponsard & Deprez, 2018). Therefore, it is vital for SMEs to manage knowledge work resources or KW and KWP (Drucker, 2006). The study of KW become a theoretical basis for SMEs to identify the knowledge work dimension and which factors realize as KWP measurement in software development process.

II   LITERATURE REVIEW

A. Conceptual Model

In order to examine KW factors and the effect to the KWP the authors used the previous KWP model (Figure 1) to conceptualize a new model for this study. KWP model is widely accepted model that provides a critical review based on the KW strategies to improved KWP. Based on the model, effectiveness and efficiency strategies was established as KW factors to improve KWP.
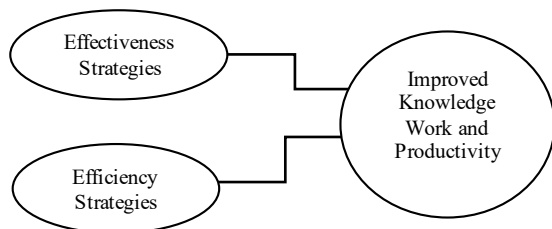
Figure 1. Effectiveness and Efficiency Strategies

B. Knowledge Work

KW involves any activities which need a specialized skills and new knowledge (Ware & Grantham, 2007). Software development process involve many activities of KW comprise of planning, analysing, monitoring, and evaluating in order to transform the information form one form to another form. First, it's important to discuss briefly the measurement factors of KW.

Davis & Naumman (1999) stated that effectiveness and efficiency are two main factors used to measure KW. Effectiveness can be measure by performing KW with more creativity which can extend the scope, depth and completeness and introduces some new applications with a new method. To archive that technology, communication, and decision-making plays major role for the knowledge worker to enhance their KW. By using latest technology will determine the individual ability and skill for KW and KWP (Spinuzzi et al., 2004). Furthermore, technology becomes vital for understanding the function of KW (Dan, 2011). The effective communication of the team of knowledge workers can reduced the time needed and improved KW (Harris, 1995). However, efficiency is how to improve the process or procedure engage using technology. It's important for knowledge workers to manage the resources in the efficient way (Liao & Yi, 2010). Dan (2011) pointed out the relationship of efficiency as measurement factors for KW under dynamic work environment.

Knowledge worker as individual who involved in the whole process of software development need to be consider based on their performance (programmer performance) (Han & Williams, 2008; Pyöriä, 2005). According to the Erne (2011) programmer performance has to be consider as specific parameter for the KW measurement based on the quality day work results and interaction, innovation behaviour, compliance with organizational standard.

SMEs also focus on collaboration aspect to improve the KW (Han & Williams, 2008; Pyöriä, 2005). In addition, improving the performance in the team work involves effectiveness, KWP and performance of organizational (Erne, 2011). The organization depends on the knowledge workers based on innovation which essential part of KW (Krishnan & Prabhu, 2003). Krishnan & Prabhu (2003) stressed that the innovation created by knowledge workers is referred to the power of intellectual capital. The impact of KW based on the innovation process through creativity and new idea revolution is an effective way to improve organization performance (Xin-miao et al., 2007).

C. Knowledge Work Productivity

KWP is known as quality of KW and describe the performance of SMEs. According to Cappola, (1991) quality are those that meet customer needs, do not fail during use, and pose no threat to human well-being. KWP is merely concern on crucial performance of knowledge worker rather than traditional meaning of the term. This is supported by Orna (2006); Fitzpatrick (1996); Denning (1992) and DeWitt, Nguyen, & Marshall (2008) state that the KWP is reflect to the how to evaluate KW results.

Table 3. Knowledge Work Factors

Authors	Knowledge Work
Harris (2010), Akdere (2009), Davis and Naumman (1999), Davenport and Prusak (1998), Spinuzzi, Hart-Davidson, & Zachry, (2004)	Effectiveness strategies
Davis and Naumman, (1999). Liao & Yi (2010), Dan (2011),	Efficiency strategies
Erne (2011), Akdere (2009).	Programmer Performance
Han & Williams, (2008); Pyöriä, (2005)	Collaboration
Krishnan & Prabhu, (2002), (Xin-miao et al., 2007), Amin, A., & Cohendet (2004)	Innovation strategies

A conceptual model is established based on the theoretical analysis and structural equation modelling method, figure 2 depicted of the overall proposed model (Drucker, 2006). The studies have found that KW measurement factors are contribute to the KWP and organizational performance. Understanding the relation between KW and KWP will provide a certain direction from a quality perspective of view. It states that KW factors can be listed as effectiveness, efficiency, collaboration, programmer performance and innovation.

III DESIGN CONCEPTUAL MODEL AND HYPOTHESIS

KW has significant effect to the KWP. To explore the effect, the conceptual model is proposed as shown in figure 2. KW factors consists of effectiveness, efficiency, collaboration, programmer performance and innovation. For the research purpose 6 hypothesis are constructed to test the correlation KW domain and KWP (Iazzolino & Laise, 2018).

- H1 KW is highly corelated with effectiveness strategies
- H2 KW is highly corelated with efficiency strategies
- H3 KW is highly corelated with programmer performance
- H4 KW is highly corelated with collaboration
- H5 KW is highly corelated with innovation strategies
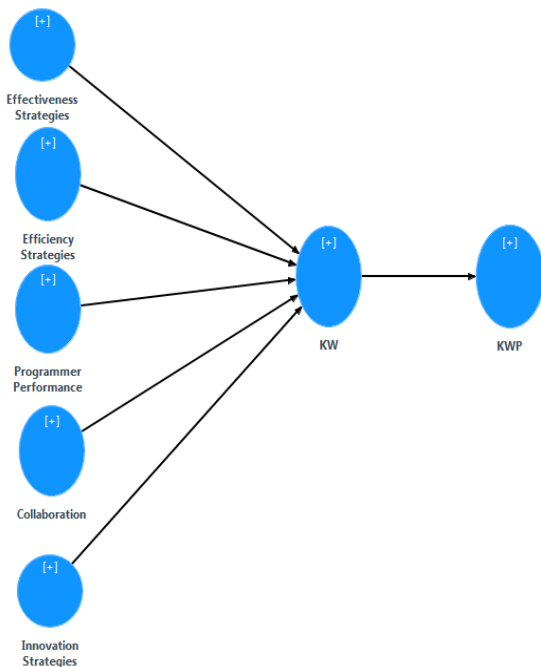- H6 KWP is highly corelated with KW

Figure 2. Proposed Conceptual Model

IV METHODOLOGY

A. Data Collection

The research instrument of this study was adopted from previous work in the literature (Zhang & Chen, 2010; Ramírez & Nembhard, 2004). In the questionnaire we used 89 questions, grouped into 4 categories. Knowledge workers with over 1–3-year work experience in software development process in SMEs, are invited for this research. Altogether 150 questionnaires were collected and valid for further analysis. The questionnaire used 7 points interval scale ranging from "strongly disagree" (1) to "strongly agree and (7). The research instrument for this research was based on content validity (the degree that measure covers the domain of interest), by discussing group of experts in the related field. The modification for item was made based on their comment. The reliability test was focusing on internal consistency of the instrument was conducted based on pilot study. The data collection procedures were done by collecting data from 30 software developers in SMEs Company. In order to analyze measurement and structural model we used SmartPLS 3. The results can be used to predict theoretical part of the model. The research instrument demonstrated satisfactory reliability and validity. Data's reliability for internal consistency is measured by composite reliability. Data's validity assessment is measured by convergent validity.

B. Data Analysis

Measurement Model. Composite reliability (CR) value shows the reliability index is more than 0.7 for 68 items used have ranged from 0 to 1. It means the value represents better internal consistency. The convergent validity test has been provided by using Fornell and Lacker two criteria: (1) The significant level for all indicators must not lower than 0.05 and their loading value is more than 0.7 or 0.6. (2) Average Variance Extracted (AVE) for each construct (AVE should exceed 0.5. All indicators loading exceeds 0.6 for the constructs at significant level $p<0.005$. In addition, AVE value for each construct exceeds more 0.50, in between ranges. For this research we find that all criteria for validity condition were satisfied.

Structural Model. The convergent validity test has been provided by using Fornell and Lacker two criteria: (1) All indicators must significant (at least at 0.05 values) and loading value must exceed 0.7 or 0.6. (2) Average Variance Extracted (AVE) construct value must exceed 0.5. For this research we have obtained results for all indicators loading exceeds 0.6 on the constructs and significant at $p<0.005$. AVE value for each construct was greater than 0.50. Based on the total effect results, we found that the effectiveness (0.193) which the highest total effect on KW, followed by programmer performance (0.179), efficiency strategies (0.026) and innovation strategies (0.047). However, collaboration (-0.082) has a negative effect on the KW and KWP.

V DISCUSSION AND CONCLUSION

This study predicted that KW has the strongest effect on KWP. We found that effectiveness strategies, efficiency strategies, and programmer performance, and collaboration and innovation strategies are highly corelated with the KW.

Having collected and analysed data we found that KWP is strongly corelated with the effectiveness strategies and programmer performance. This is line with the previous conceptual model (Davis & Naumman, 1999) and previous studies (Erne, 2011). Effectiveness is concern how we archive the target and how we solve the problems and the strategies used to improve KWP. Effectiveness has a significant relation to KW and give strongest total effect positive effect on the KWP. In addition, programmer performance also has strong positive effect to the KWP.

Programmer performance is related to the accomplishment of a given task. This is measured against present known standards of accuracy, completeness, cost, and speed. In the KW context performance measurement totally different from using performance measurement in a more traditional setting. Success factors in knowledge work are more resource orientated. The measures considering the results, external key stakeholders or processes are somewhat similar.

Efficiency was another KW factors found not significantly influence on KW. Efficiency mainly concerns to the efficient ways to manage the resources, eliminate waste, and reduce cost. Efficiency is still having the positive effect KW and KWP. One plausible explanation for the non-significant explanation result in efficiency is the context of the study. This study emphasizes the individual's role as software developers.

Innovation strategies is the creation of better or more effective products, processes, services, technologies, or ideas that are accepted by markets, governments, and society. It related to the creative and novel fashion on a process engage to the improvement effectiveness and efficiency or marketability. Innovation Strategies has less significant results to the KWP, but still important for software developers become more innovative towards quality improvement in KW.
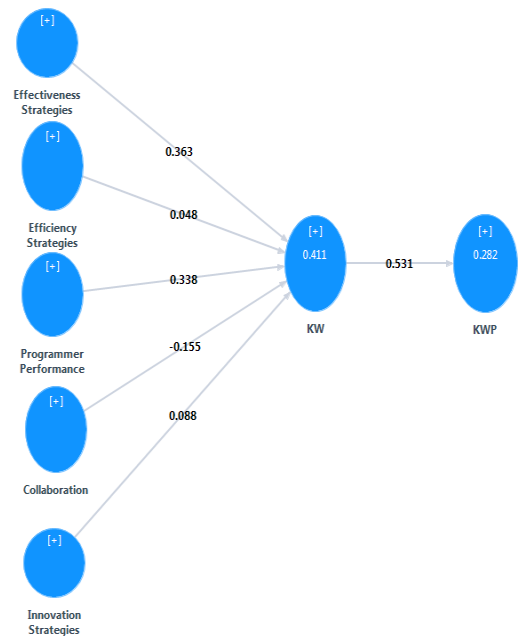

Figure 3. Results of the Structural Model

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