A KNOWLEDGE MANAGEMENT PERFORMANCE MEASUREMENT
SYSTEM FOR SMALL AND MEDIUM ENTERPRISES

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Dedicated to my beloved family and friends

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ABSTRACT

An important step after the implementation of knowledge management (KM) is to evaluate its effectiveness and performance. Knowledge management performance measurement (KMPM) is necessary in order to achieve effective and successful KM. Comprehensive set of constructs and metrics for KMPM have yet to be developed. In addition, a KMPM system that applies these constructs and metrics is found lacking. It is more apparent in the case of small and medium enterprises (SMEs) as most of the studies have focused on large organizations. Furthermore, as KM is characterized by an environment subject to uncertainties and fuzziness, there is a need to adopt a specific approach to address this issue. In this research, the focus is on the development of a KMPM system for the SMEs. A novel conceptual framework that categorized KM into three main aspects; knowledge resources, KM processes, and KM factors was used as a foundation for developing the system. New set of KMPM constructs and metrics were developed and tailored for the SMEs. Investigation of the developed constructs and metrics in terms of their applicability was carried out through a questionnaire survey. The constructs and metrics were validated through statistical analysis using the Statistical Package for the Social Sciences, where reliability analysis was conducted followed by validity analysis in terms of content, construct, convergent, discriminant, and criterion validities. The analysis results indicated that the developed constructs and metrics were applicable, reliable, and valid. Following this, a fuzzy logic methodology was utilized as the evaluation mechanism for the KMPM system. MATLAB software was used to develop the fuzzy inference system and Simulink was used to design and develop the system's layout and interface. Case studies were conducted in three small and medium sized consultancy companies to evaluate the developed system. From the evaluation, the evaluators commented that the system was comprehensive, user-friendly, and suitable for SMEs application. In essence, this research has developed new set of constructs and metrics as well as a KMPM system specifically designed for SMEs.

ABSTRAK

Satu langkah penting selepas pelaksanaan pengurusan pengetahuan (KM) adalah untuk menilai keberkesanan dan prestasinya. Pengukuran prestasi pengurusan pengetahuan (KMPM) adalah penting untuk mencapai KM yang berkesan dan berjaya. Satu set konstruk dan metrik yang menyeluruh untuk mengukur prestasi KM masih belum dibangunkan. Selain itu, sebuah sistem pengukuran yang menggunakan konstruk-konstruk dan metrik-metrik ini didapati masih kurang. Ia adalah lebih ketara dalam kes perusahaan kecil dan sederhana (SMEs) kerana kebanyakan kajian telah memberi tumpuan kepada organisasi besar. Tambahan pula, oleh sebab KM mempunyai ciri-ciri persekitaran yang tertakluk kepada ketidaktentuan dan kekaburan, terdapat keperluan untuk mengguna satu pendekatan yang khusus bagi menangani isu ini. Dalam kajian ini, tumpuan diberikan kepada pembangunan sistem KMPM untuk SMEs. Satu rangka kerja konsep novel yang mengkategorikan KM kepada tiga aspek utama: sumber-sumber pengetahuan, proses-proses KM, dan faktor-faktor KM telah digunakan sebagai asas bagi membangunkan sistem ini. Satu set konstruk dan metrik baru yang sesuai untuk SMEs telah dibangunkan. Siasatan dari segi aplikasi bagi konstruk-konstruk dan metrik-metrik yang dibangunkan telah dilakukan melalui kajian soal selidik. Konstruk-konstruk dan metrik-metrik ini telah disahkan melalui analisis statistik menggunakan *Statistical Package for the Social Sciences*, di mana analisis kebolehpercayaan telah dijalankan dan diikuti oleh analisis kesahihan dari segi analisis kandungan, konstruk, tumpu, diskriminan, dan kriteria. Keputusan analisis menunjukkan bahawa konstruk-konstruk dan metrik-metrik yang dibangunkan boleh diaplikasi, dipercayai, dan sah. Selepas ini, kaedah logik kabur telah dicadangkan sebagai mekanisme penilaian untuk sistem KMPM tersebut. Perisian MATLAB digunakan untuk membangunkan sistem inferens kabur dan Simulink digunakan untuk mereka-bentuk dan membangunkan susun atur dan antara muka sistem. Kajian kes telah dijalankan di tiga buah syarikat perundingan bersaiz kecil dan sederhana untuk menilai sistem yang telah dibangunkan. Daripada hasil penilaian, didapati penilai-penilai mengulas bahawa sistem yang dibangunkan adalah menyeluruh, mesra-pengguna, dan sesuai untuk aplikasi SMEs. Pada dasarnya, kajian ini telah membangunkan satu set konstruk dan metrik baru serta satu sistem KMPM yang direka khusus untuk SMEs.

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LIST OF SYMBOLS

e	-	The desired level of precision
n	-	Sample size after finite population correction
$n_\circ$	-	Sample size
N	-	Population size
P	-	Index of Performance Evaluation
p	-	The estimated proportion of an attribute that is present in the population
q	-	1- p
R	-	Correlation between the independent variables and the dependent variable
Z	-	The abscissa of the normal curve

LIST OF ABBREVIATIONS

AHP	-	Analytical Hierarchy Process
ANP	-	Analytical Network Process
AVE	-	Average Variance Extracted
BSC	-	Balanced Scoredcard
DEA	-	Data Envelopment Analysis
ER	-	Evidential Reasoning
GDP	-	Gross Domestic Product
HRA	-	Human Resource Accounting
HRM	-	Human Resource Management
IAM	-	Intangible Assets Monitor
ICT	-	Information Comunications Technology
IT	-	Information Technology
KA	-	Knowledge Acquisition
KAU	-	Knowledge Application and Utilization
KCG	-	Knowledge Creation and Generation
KCP	-	Knowledge Circulation Process
KCS	-	Knowledge Codification and Storing
KD	-	Knowledge Disposal
KI	-	Knowledge Identification
KM	-	Knowledge Management
Kmap	-	Knowledge Mapping
KME	-	Knowledge Management Enabler
KMO	-	Kaiser-Meyer-Olkin
KMPI	-	Knowledge Management Performance Index
KMPM	-	Knowledge Management Performance Measurement

KMR	-	Knowledge Management Result
KP	-	Knowledge Protection
KTS	-	Knowledge Transferring and Sharing
MCDM	-	Multi-Criteria Decision Making
MLS	-	Management Leadership and Support
OI	-	Organizational Infrastructure
Mux	-	Multiplexer
PCA	-	Principal Component Analysis
R&D	-	Research and Development
SME	-	Small and Medium Enterprise
SN	-	Skandia Navigator
SPSS	-	Statistical Package for the Social Sciences
TE	-	Training and Education
USBS	-	User Satisfaction Based System

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CHAPTER 1

INTRODUCTION

1.1 Overview

In recent years, knowledge management (KM) has become a very common term. It has been widely used by companies ranging from large multinational corporations to small and medium enterprises (SMEs) in managing their knowledge assets (Okunoye and Karsten, 2002; Zieba et al., 2016). Companies and organizations are well aware of the benefits they can gain from it and how important it is in helping them to stay competitive. Thus, it is important to ensure that the implemented KM programs are effective and efficient. One of the methods to know the performance of KM is through evaluation or measurement (Valmohammadi, and Ahmadi, 2015). Knowledge management performance measurement (KMPM) is vital as it enables an organization to evaluate, manage, and improve its KM initiatives (Wong, 2005). However, it is not an easy task due to its characteristic that is subjective and intangible (Kluge et al., 2001).

While KM has been acknowledged to improve organizational performance and provide competitive advantage, there are no well-developed KMPM models or tools for SMEs. KMPM tools that exist were developed based on the needs of large

multinational companies. Many researchers that are expert in the field of SMEs such as McAdam and Reid (2001), Desouza and Awazu (2006), Hutchison and Quintas (2008), Durst and Wilhelm (2012), Janet and Alton (2013), Wee and Chua (2013), and Zieba et al. (2016) have done empirical studies to prove that KM for large organizations and SMEs are not the same. Therefore, existing KMPM tools may not be suitable to be applied directly in SMEs. Basically, there is a lack of KMPM models specifically designed for SMEs. Thus, the purpose of this study is to address this gap by designing a suitable KMPM system specifically for SMEs.

1.2   Background of the Research

In the 21st century, knowledge capital has replaced the traditional capital and became an important resource of the modern enterprises. Due to this, knowledge has become a strategic resource and a subject of management for either large organizations or SMEs (Chen and Miao, 2010).

For SMEs, their knowledge-based resources are usually more important than their property-based resources (Wiklund and Shepherd, 2003). To be able to compete in dynamic environments, SMEs have to excel in managing their knowledge resources as they have become an important determinant of survival. To achieve this, SMEs must have the ability to search for knowledge, share knowledge, synthesize new and existing knowledge, and utilize them (Nunes et al., 2006; Hutchison and Quintas, 2008).

KMPM is a crucial step after the implementation of KM initiatives as it enables companies to keep track of their KM activities so that decisions can be made on what to continue, what to improve, and what to discard (Andone, 2009). A variety of tools and models that were designed to help organizations in measuring KM

performance can be found in the literature but a specific one tailored to meet the needs and characteristics of SMEs was found to be lacking. The focal point is on large organizations, leaving SMEs unattended. KMPM in SMEs has received little attention from researchers (Rebecca and Pun, 2014; Lee and Wong, 2015). Even after more than a decade of exploration, researchers are still dwelling on the implementation stage. Without measurement, SMEs that have implemented KM may not be able to make sound judgment in improving their KM initiatives.

In general, SMEs need more research attention as they too need KMPM to ensure the success of their KM endeavors so that their efforts and resources devoted to KM are not wasted.

1.3   Problem Statement

Looking at the literature of KM, the lack of research on SMEs is so apparent compared to large organizations (Hutchison and Quintas, 2008; Coyte et al., 2012). The case is even more obvious regarding the research on KMPM in SMEs as to date, little can be found in the literature.

Researchers are focusing on large firms and assuming that SMEs are the same except for sizes. Yet, experts in the field of SMEs such as McAdam and Reid (2001), Desouza and Awazu (2006), Hutchison and Quintas (2008), Durst and Wilhelm (2012), Janet and Alton (2013), and Zieba et al. (2016) have done empirical research to show that the above assumption is wrong as KM in large organizations is different compared to SMEs in many aspects. These differences are caused by the size of the organization which then affects its structure and organizational behavior (Rutherford et al., 2001; Montequín et al., 2006). Thus, the KMPM tools that have been created based on large organizations are not meant to be applied directly in SMEs.

Furthermore, most of the existing KMPM constructs and metrics for SMEs are merely the suggestion or observation of researchers without any proper validation process to verify if they are suitable or reliable to be applied. Hence, using inappropriate measurement tools and improper measurement metrics may provide inaccurate results that may mislead managers in making the right decisions and taking appropriate actions.

SMEs have limited resources and are short of proper information technology (IT) tools or expertise for structured measurement and reporting (Desouza and Awazu, 2006; Coyte et al., 2012). As an example, they usually resolved in using manual filing systems to store knowledge and information rather than using high cost computer-based systems. This causes data collection and retrieval for measurement purposes to be a tedious job. Besides, it will be time consuming to obtain accurate and complete data needed for KMPM, which is another setback of the current KMPM models.

Furthermore, the major issue faced in KMPM is the subjectivity and qualitative nature of the metrics used. In practice, most of the data required for performance evaluation are difficult to be quantified and they may not be precise with crisp boundaries, making them fuzzy or vague. Rather, it is more practical to quantify this information in expressions or words in a natural language and with less precision. In addition, existing measurement models assume that all variables are definite. Whereas in real life, KM activities are vague and ambiguous as they are affected by uncertainties which make them as fuzzy events. Ignoring the fact that KMPM is bounded to have a certain degree of fuzziness would render the measurement results less reliable. Hence, considering the fuzzy nature of KM during KMPM is critical as it provides a better assessment.

As a solution, a measuring system that incorporates fuzzy logic can be applied to cope with the problems that SMEs are facing. It is a practical approach in examining many real-world problems as this technique is based on the fuzzy set

theory that allows the elements of a set to have varying degrees of membership, from a non-membership grade of 0 to a full membership of 100 per cent or grade 1. This smooth gradation of values is what makes fuzzy logic matches well with the typical vagueness and uncertainty of many real-world problems (Beheshti and Lollar, 2008). Hence, it has the capability to cope with the vagueness and uncertainty in the evaluation of KM performance with the use of linguistic assessment.

1.4   Objectives of the Research

Based on the problem statement, three objectives have been designed to cope with the problems that SMEs are facing such as the lack of KM performance measurement models, fuzziness of measurement data, and limitation of time and resources, etc.

The objectives of this study are:

(i)   To develop a set of KMPM constructs and metrics that is suitable for SMEs.

(ii)   To validate the developed KMPM constructs and metrics.

(iii)   To develop a KMPM system based on the fuzzy logic methodology.

1.5 Scope of the Research

The scopes of this research are:

(i) The study area will be focused on the service sector of SMEs only as majority of SMEs in Malaysia are in the service sector (SME Corporation Malaysia, 2014).

(ii) The target respondents will be limited to consultancy firms only since they are the knowledge intensive firms and the probability of KM being adopted or implemented in these companies would be higher.

(iii) Data collection will be carried out through conducting a survey.

(iv) Statistical Package for the Social Sciences (SPSS) will be used to analyze the collected data (reliability and validity tests).

(v) The development of the KMPM system will be based on the fuzzy logic approach.

(vi) Matlab software (Fuzzy Logic Toolbox) will be used to develop the fuzzy inference system as it is the industry standard computing platform that is widely used. It is also a mature program that is heavily supported and allows for quick prototyping of ideas.

(vii) Simulink software will be used to design the KMPM system's layout and interface. It is a graphical extension to Matlab which enables data to be transferred easily and it is also highly flexible and user-friendly in performance modeling and simulation.

1.6 Significance of the Research

This research opens a new perspective in designing a KMPM system for SMEs. It also creates awareness on the importance of KMPM in ensuring the success of KM initiatives, where it has been neglected by SMEs. This study provides

guidelines on which aspects of KM that companies have to improve in order to achieve good performance and excel in managing their knowledge assets. This will also act as a starting point to boost research in this particular field, given the lack of research that is focusing on KMPM in SMEs.

This study will provide a new comprehensive set of KMPM constructs and metrics that is tailored to suit the characteristics of SMEs. The proposed constructs and metrics will be validated through proper analysis to ensure their applicability and reliability. Finally, by using the fuzzy logic approach, this study can provide a flexible and efficient measurement system that can help SMEs in evaluating their KM performance.

1.7   Outline of the Thesis

This thesis consists of eight (8) Chapters, with Chapter 1 being a brief introduction to the research. It also discusses the problem statement which forms the basis of the research, the objectives, and the scope of the study. The 2nd Chapter looks at the review of literature on related issues, work and research. It also provides the descriptions of various terminologies associated with this research. The 3rd Chapter describes the methodology adopted. This includes all the steps involved in conducting this research. The 4th Chapter discusses the development and justification of the KM performance constructs and their metrics which will be used in the measurement system. Chapter 5 presents the survey results together with statistical analysis that includes reliability and validity analysis in order to substantiate the applicability of the performance constructs. The 6th Chapter looks into the development of the KMPM system using the fuzzy logic methodology. The methodology will be demonstrated with an illustrative example. This Chapter covers the development of the KMPM system, including the development of the fuzzy rule-based system and the system interface followed by validation. Chapter 7 deals with

the evaluation of the developed system by conducting case studies in SMEs in Malaysia. The evaluation results, improvements made and their implications are discussed. The final Chapter concludes the research and provides recommendations for further studies on KMPM in SMEs.

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