KNOWLEDGE GRID TO FACILITATE KNOWLEDGE SHARING MODEL IN BIG DATA COMMUNITY

By

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In many scientific and business areas big data needs to analyze and flow between the users which can help answer questions and solve many problems if it is extracted by experts who are known as data scientists. This group of big data users comes together by merging and supporting knowledge management system characteristics as a big data community to help capture and share expertise, experiences, and ideas. Thus, their communication and sharing of knowledge which includes knowledge transferring and knowledge receiving are fundamental for community existence. A knowledge grid as a communication infrastructure can provide a foundation for exchanging huge among of data and information efficiently. However, reliability, accessibility, validity, and security of information are the most concern and affect knowledge sharing among the big data community while the current knowledge sharing model's approaches to solving and answering these problems had been limited by specific aspects. In this regards a systematic literature review had been conducted to analyze the research gap and influencing factors. The study explored the factors, which affect knowledge sharing and their relationship with the knowledge grid component in the big data community and it listed several factors which influence knowledge sharing that can categorize from the user, organization, and technological aspects. From the previous related literature and theoretical methods, a conceptual model with seven independent variables, motivation, organization relationship, resource sharing rules, top management support, software application quality, data security, and network quality had been designed. The research model defined node density and link strength as a mediator for facilitating knowledge sharing. Based on the model a survey had been designed which was reviewed by three experts for face and content validity before the pilot study on 20 participants. The collected data from the pilot study had been evaluated for internal consistency and the revised questionnaire had been used for empirical analysis. The empirical study had been performed with 106 respondents by using SPSS for descriptive analysis and PLS-SEM for statistical analysis in which nine hypotheses were tested. The results indicated that from nine constructs, six of them are statistically significant in facilitating knowledge sharing. The revised conceptual model

had been validated in the developed prototype, reviewed by experts, and the System Usability Score. In the last part of the research, all the research findings and contributions had been represented. Thus, based on the investigated factors that affect knowledge sharing and their relationship with the knowledge grid component in the big data community and hypotheses analysis, the represented knowledge sharing model had been found useful and improved decision making and problem solving among the big data community.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

GRID PENGETAHUAN UNTUK MEMUDAHKAN MODEL PERKONGSIAN PENGETAHUAN DALAM KALANGAN KOMUNITI DATA RAYA

Oleh

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Dalam banyak bidang saintifik dan perniagaan, data besar perlu dianalisis dan bergerak antara pengguna yang boleh membantu menjawab soalan dan menyelesaikan masalah jika ia diekstrak oleh pakar yang dikenali sebagai saintis data. Kumpulan pengguna data besar ini bersatu dengan menggabungkan dan menyokong ciri sistem pengurusan pengetahuan sebagai komuniti data besar untuk membantu mengenal pasti dan berkongsi kepakaran, pengalaman dan idea. Oleh itu, komunikasi dan perkongsian ilmu mereka yang merangkumi pemindahan ilmu dan penerimaan ilmu adalah asas untuk masyarakat. Grid pengetahuan sebagai infrastruktur komunikasi boleh menyediakan asas untuk bertukar-tukar data yang banyak dan maklumat dengan pantas. Walau bagaimanapun, kebolehpercayaan, kebolehcapaian, kesahihan dan keselamatan maklumat adalah yang paling membimbangkan dan mempengaruhi perkongsian pengetahuan dalam kalangan komuniti data besar manakala pendekatan model perkongsian pengetahuan semasa untuk menyelesaikan dan menjawab masalah ini telah dihadkan oleh aspek tertentu. Dalam hal ini, kajian literatur yang sistematik telah dijalankan untuk menganalisis jurang kajian dan faktor-faktor yang mempengaruhi. Kajian itu melibatkan faktor, yang mempengaruhi perkongsian pengetahuan dan hubungannya dengan komponen grid pengetahuan dalam komuniti data besar dan ia menyenaraikan beberapa faktor yang mempengaruhi perkongsian pengetahuan yang boleh dikategorikan daripada aspek pengguna, organisasi dan teknologi. Daripada literatur berkaitan dan kaedah teori sebelumnya, model konsep dengan tujuh pembolehubah tidak bersandar, motivasi, hubungan organisasi, peraturan perkongsian sumber, sokongan pengurusan atasan, kualiti aplikasi perisian, keselamatan data dan kualiti rangkaian telah direka. Model penyelidikan mentakrifkan ketumpatan nod dan kekuatan pautan sebagai pengantara untuk memudahkan perkongsian pengetahuan. Berdasarkan model satu tinjauan telah direka bentuk yang telah disemak oleh tiga pakar untuk mengenal pasti muka dan kandungan sebelum kajian rintis ke atas 20 peserta. Data yang dikumpul daripada kajian rintis telah dinilai untuk konsistensi dalaman dan soal selidik yang disemak telah digunakan untuk analisis empirikal. Kajian empirikal telah dilakukan dengan 106 responden dengan

menggunakan SPSS untuk analisis deskriptif dan PLS-SEM untuk analisis statistik di mana sembilan hipotesis telah diuji. Keputusan menunjukkan bahawa daripada sembilan konstruk, enam daripadanya adalah signifikan secara statistik dalam memudahkan perkongsian pengetahuan. Model konseptual yang disemak telah disahkan dalam prototaip yang dibangunkan, disemak oleh pakar, dan ujian Skor Kebolehgunaan Sistem. Pada bahagian terakhir penyelidikan, semua dapatan kajian dan sumbangan telah diwakili. Oleh itu, berdasarkan faktor yang disiasat yang mempengaruhi perkongsian pengetahuan dan hubungannya dengan komponen grid pengetahuan dalam komuniti data besar dan analisis hipotesis, model perkongsian pengetahuan yang diwakili telah didapati berguna dan membuat keputusan serta penyelesaian masalah yang lebih baik di kalangan komuniti data besar.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AVE	Average Variance Extracted
BD	Big Data
BDA	Big Data Analysis
BDC	Big Data Community
CI	Consistency Index
CM	Consistency Measure
CR	Composite Reliability
CVI	Content Validity Index
DS	Data Security
FKS	Facilitate Knowledge Sharing
ICT	Information and Communication Technology
IS	Information System
ISSM	Information System Success Model
IT	Information Technology
KG	Knowledge Grid
KM	Knowledge Management
KS	Knowledge Sharing
LS	Link Strength
M	Motivation
ND	Node Density
NQ	Network Quality
OR	Organization Relationship
PLS	Partial Least Square

PLS-SEM	Partial Least Square-Structural Equation Modelling
RSR	Resource Sharing Rules
SAQ	Software Application Quality
SEM	Structural Equation Modelling
SPSS	Statistical Package for Social Science
SUS	System Usability Scale
TAM	Technology Acceptance Model
TMS	Top Management Support
TOE	Technology-Organization-Environment Framework
UI	User Interface

CHAPTER 1

INTRODUCTION

1.1 Research Background

The rapid increase in computer processing, data storage, and communication, drive users to improve their knowledge resources by using big data (BD). Knowledge management (KM) is defined as the process that helps organizations and individuals to identify, select, organize publish and transfer knowledge to the right people at right time (Abdullah, 2008), which makes problem solving, decision making, strategic planning, productivity, and services more effective and efficient. A proper KM system and advanced semantic reasoning are essential in promoting innovation and productivity in any cooperative environment (Nya and Tan, 2016). Knowledge sharing (KS) as transferring knowledge to the authorized user in real time (Abdullah, 2008) can help to reduce significant time and cost in collaborative environments.

Hendriks, (1999) defined KS as part of KM which has two components, knowledge transferring and knowledge receiving, while knowledge transferring is the dissemination of personal ideas, techniques, suggestions, and expertise among individuals and the community; knowledge receiving means acquiring knowledge (Kim et al., 2012).

Many individuals use the big data community (BDC) for seeking knowledge to improve their decision making and solving problems and it became big support for to develop and growth of the different communities of practices to meet their business needs and objectives (Chiu et al., 2006), (Zheng et al., 2013). The BDC based approach is an effective way of sharing knowledge, and it will be successful if gains and keep its members (Lin, 2008).

Users are the main component of any community, thus, in BCD big data users as individuals or organizations play an important role. While there is a lack of research focusing on community members' roles and influence on the communication platform (Nya and Tan, 2016) such as the knowledge grid. users' behavior and expectation of knowledge grid system and their effect on the grid system.

A grid was originally designed for dealing with problems involving large amounts of data or compute-intensive applications (Aminu, 2014). The grid is an effort to create an advanced cyberinfrastructure, aiming at an adaptive wide-area resource environment, integrating higher-level services that enable applications to adapt to heterogeneous and dynamically changing meta-computing environment, with ease, low cost, reliability, and regardless of the location and device (Zhuge and Sun, 2016). A knowledge grid

(KG) as a communication infrastructure can provide a foundation for exchanging huge among of data and information efficiently (Wang et al., 2006). It was designed for implementing data mining services and applications involving resource management to provide a system for describing, and publishing information from data sources, computing resources, and data mining algorithms (Cesario et al., 2007). It provides required services for cooperative teamwork for problem-solving and decision making. KG is an intelligent and sustainable internet application environment that enables users to effectively publish, share and manage knowledge while its mechanism facilitates interoperation between users (Hengshan and Liqun, 2005).

1.2 Problem Statement

Big data as a huge pool of data become a major concern for various organizations' activities to improve their decision making, services, and productivity. Therefore, the variety of data sources should combine which required collaboration between organizations and companies to acquire resources and improve analysis abilities. Big data users can consider BDC when there is a compelling relationship among them and collected data from parties, stream between members as individuals or organizations (Nya and Tan, 2016). However, because of the complexity of BD cannot use the traditional way to manage data, and in specific complex knowledge sharing as transferring knowledge to the authorized user in real time (Abdullah, 2008), so, firms have developed different infrastructures to interact with big data users (Wamba et al. 2017).

Therefore, sharing data and information needs to be stable and controlled to maximize its outcome, while organizations store large scale datasets which carriages the enormous task of sharing and integrating crucial information across them and establishing close connections and harmonization with their business allies (Al-Nuaimi et al., 2015). However, the current situation of KS in big data chaos has a significant distance from facilitating (Dutta and Bose, 2015).

Almost every area such as health, city management, business, education, environment, energy, security, etc. fascinated to have social interaction, share their interest, and build relationships among the community to swap experiences and ideas (Lin, 2008). However, challenges will raise to access, manage, analyzing, sharing, and using big data, because of big data characteristics (Zhuge and Sun, 2016). Rapid processing of many metadata records and datasets to satisfy a large number of users' will be difficult. Also managing the increasing rate of data flows for highly heterogeneous data models, encoding formats, and access service interfaces are challenging (Che et al., 2013; Chen and Zhang, 2014).

Because of the amount of data and their complexity, it is important to be aware of the data and clarify that they are comparable when different datasets are merged (Fredrikson, 2015; Janssen and Wahyudi, 2017).

The issue reveals when the amount of accumulated data is becoming so large that finding the most valuable pieces of information is complicated (Chandhini and Megana, 2013). The huge size of data needs more capacity of security for sharing. Otherwise, most BD is stored in a distributed way, and the threats from networks also can aggravate the problems (Chen and Zhang, 2014). Enormous data from different sources, types, and processes are greatly interconnected, and interrelated is complicated to analyze, manage, and share in real time (Che et al. 2013). The reliability of data is a challenge to deal with, to be able to make justified decisions based on the data (Dong et al., 2015; Chen and Hung, 2012).

Hence, reliability, accessibility, validity, and security of information are the most concern and challenges in knowledge sharing among the big data community (Sivarajah et al., 2017; Dong et al., 2015; Fredriksson, 2015). Even though the current knowledge sharing model's approaches to solving and answering these problems had been limited by specific aspects such as organizational (Alali and Salim, 2013; Kharabsheh, 2010) or technological (Zheng et al., 2013). Also, their result focused on knowledge management and knowledge sharing collaboration (Nya and Tan, 2016) or knowledge sharing behavior (Alali and Salim, 2013).

A knowledge grid is a dynamic distributed system, which connected knowledge worldwide and guaranteed proper knowledge clustering as a minimum complete knowledge set for solving problems stored (Zhuge and Sun, 2016). Aminu, 2014, claimed that a knowledge grid had been designed to help solve problems involving a large amount of data, and Nakanishi et al., 2011, defined a knowledge grid as well-organized knowledge connected that enables control sharing of various kinds of sources. However, there is a lack of investigation in the knowledge sharing models of the effects of knowledge grid infrastructure in knowledge sharing and its ability to manage complex and huge amounts of data such as big data that had not been studied for facilitating knowledge sharing.

1.3 Research Question

The three research questions have been designed to lead the research process which is listed below:

i. What are the factors that facilitate knowledge sharing among the big data community?

ii. What are the significant components of the knowledge grid influencing knowledge sharing in the big data community?

iii. How are the Knowledge grid factors linked to facilitating knowledge sharing through the big data community?

1.4 Research Objectives

The study objectives have been explained and categorized as follows:

i. To analyze the factors, that affect knowledge sharing and their relationship with the knowledge grid component in the big data community.

ii. To propose and evaluate a new model for improving knowledge sharing among the big data community.

iii. To evaluate the final suggested model by using prototype tools and usability tests.

1.5 Scope of Research

This study focused on investigating factors that are effective in facilitating knowledge sharing and their relationship with knowledge grid components among the big data community. It narrowed the big data users to data scientists who are able to bring structure to large quantities of formless data and make analysis possible in several industries including academics and artificial intelligence and software development. The big data community provides an opportunity for big data users to share their knowledge and experiences to decrease redundancy and improve decision making and problem-solving. Thus, a suitable platform to facilitate knowledge sharing such as a knowledge grid designed to distribute a huge amount of data is essential.

Based on the result of the literature reviewed, a conceptual model had been developed and had been evaluated by different validation methods including expert review and collecting primary data. Data scientists as target users participate in the survey to evaluate the designed model and related prototype.

1.6 Research Contribution

To share the knowledge created from big data a suitable infrastructure to provide time concerned, secure, and easy-to-use platform is compulsory. The research theoretical contribution provides the conceptual model to facilitate knowledge sharing among big data users by identifying the factors which affect knowledge sharing concerning knowledge grid components.

The practical contribution of this study lies implementation of the proposed model which help data scientist collaborate in terms of the community to avoid redundancy in big data analysis. In this way, it developed a prototype based on the modified model and evaluate its usability for facilitating knowledge sharing.

1.7 Thesis Organization

This thesis represents eight chapters which are organized as below:

Chapter 1, the introduction, represents the research background and problem statement. It provides the research questions and objectives while explaining the scope of study and contribution.

Chapter 2, literature review provides a full review and discussion of all the relevant studies such as journals, conference proceedings, books, and et. The related previous KS models had been analyzed and the relevant theoretical methods had been explored in the chapter.

Chapter 3, research methodology, provides a complete discussion of the methodology that had been used in this research. It represents the expert review result and the evaluation of the theoretical model. It also explains the pilot study result, sample choosing method, and validity of the survey.

Chapter 4, model development, explains the conceptual model attributes and develops the hypothesized model.

Chapter 5, the empirical study, provides the assessment of measurements and structural model while explaining the research finding of the relationship between proposed constructs. It also represents the result of hypothesis analysis and based on its modified model been illustrated.

Chapter 6, prototype development and implementation of the proposed model, illustrates the prototype designing process. The expert review and usability test result of the prototype explain in full detail.

Chapter 7, results, and discussions, provides the finding of the study and discusses the results of the study based on the prototype evaluation.

Chapter 8, conclusions, and future work, represent the research conclusion and highlight the study limitation and direction for future study.

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