Developing and Validating Measures of Knowledge Management Effectiveness with CFA

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The objective of this study is to examine the construct of Knowledge Management Effectiveness (KME) using two sub-constructs; knowledge infrastructure capability (KIC) and knowledge process capability (KPC). The construct of knowledge infrastructure capability consists of four dimensions: structural knowledge, cultural knowledge, technical knowledge, and human resource knowledge. The sub-construct of knowledge process capability consists of the acquisition process, conversion process, and application process. The research also attempts to measure and validate the main construct and sub-constructs using data collected from Jordanian banks. Adapted instruments were determined using a questionnaire research methodology approach on 316 employees working in Jordanian banks. A confirmatory factor analysis technique was implemented to verify and validate the measurement model of the knowledge infrastructure capability (KIC) and knowledge process capability (KPC) model to measure main construct knowledge management effectiveness. The research finding presents the revised measurement model for knowledge infrastructure capability (KIC) and knowledge process capability (KPC) to be involved in knowledge management effectiveness. All four variables of the knowledge infrastructure capability (KIC) and three variables of and knowledge process capability (KPC) emerged as significant and reliable measures for knowledge management effectiveness. The research contributed to a unique perspective of KM effectiveness, the confirmed and validated set of measurement items can be used to measure the extent to which knowledge infrastructure capability (KIC) and knowledge process capability (KPC) is involved in knowledge management effectiveness in the organisations. Through the validated tool, more research can be carried out to explore knowledge management effectiveness from the employee's perspective.

Key words: *Knowledge management effectiveness, Knowledge infrastructure capability, Knowledge process capability, structural knowledge.*

Introduction

The essence of knowledge management (KM) has been fully documented as businesses are beginning to accept the notion that knowledge and innovation as significant contributors to organisational success and competitiveness (Omerzel, 2010). As a result, many researchers are found engaging in research in various areas of KM involving technological, infrastructural, financial or human perspectives within the organisations [24-28].

Knowledge management research has most explicitly discussed whether knowledge is a possession or if it is set in practice by separating knowledge and knowing (Orlikowski, 2002). Therefore, knowledge can be conceded as something that individuals, groups or organisations have (knowledge as ownership); but also, something that individuals, groups, and organisations view (knowledge as a system). Both forms of knowledge have a position to play, depending on the types of knowledge and tasks that are involved. Researchers have developed this idea of knowledge management.

Practical evidence in knowledge management literature also suggests that to achieve a better understanding of knowledge management effectiveness, companies should attempt to link knowledge processes (KPC) and resources (KIC) (Carlucci, Marr, and Schiuma, 2004; Gold, Lee, and Choi, 2003, Rahman and Castelli, 2013, Raza et al., 2017, Saeed and Kayani, 2018, Sandy,2018, Seddighi and Yoon, 2018, Sen et al., 2017). These capabilities are provided towards the operational functioning of the firm, and they can affect performance measures and lead to above-average returns.

This research applied the Lindsey (2002) model developed to measure knowledge management effectiveness. The main model goal was to quantify the results of organisational efforts to manage knowledge. Lindsey (2002) combined two theories in his model that have been developed to explain the processes of knowledge management in organisations. Gold et al. (2001) introduced a model relating organisational effectiveness with two necessary capabilities; knowledge infrastructure capability and knowledge process capability. The other model is the Becerra-Fernandez and Sabherwal (2001) model; this model developed theories relating knowledge management processes and knowledge management satisfaction in a task-contingent manner.

Literature Review

A. Knowledge management effectiveness

Knowledge management effectiveness is analysed from a process perspective (Gold, Malhotra, & Segars, 2001). In general, knowledge management effectiveness is conceived as the effectiveness of an organisation in managing the knowledge acquired, shared and applied by its employees. In summary, knowledge management effectiveness is considered as a process to enhance knowledge application to achieve organisational innovation for improving business performance. Organisations that effectively manage their knowledge within an organisation will have higher organisation innovation in turn to accomplish a breakthrough competitive advantage (Altarwneh et al., 2019).

This research applied the Lindsey (2002) model to measure knowledge management effectiveness using both knowledge infrastructure capability and knowledge process capability. The dimensions of measuring knowledge infrastructure capability including structural knowledge, cultural knowledge, technical and human resource knowledge, are adapted and adopted from Chuang's (2004) study. Moreover, to measure knowledge process capability, this study adapted and adopted Lee and Sukoco's (2007) study.

B. Knowledge infrastructure capability

Knowledge infrastructure capability is operationalised through four dimensions: structural KM resources, cultural KM resources, technical KM resource and human KM resources. Technology provides the network, structure provides the relationship, and culture provides a shared context. Studies have considered structure, culture, technology, and human knowledge as KM infrastructure capabilities or resources (Agbim, Oriarewo, & Owutuamor, 2013; Chuang, 2004; Gold et al., 2001; Lee & Choi, 2003). Technical knowledge management resource is the KM infrastructure that is essential for initiating and carrying out KM (Chuang, 2004). The technical KM resource includes information technology (IT) assets, which enable a firm to generate new knowledge. In other words, technical KM determines how knowledge travels throughout the enterprise and how knowledge is accessed (Zaied et al., 2012). Structural KM resources such as culture may encourage or inhibit knowledge management (Holsaple & Jushi, 2001; Nonaka, 2007). Human KM resources include employees' knowledge of a discipline and how their discipline interacts with other disciplines (Chuang, 2004). Human KM resources are often tacit and dependent on other interpersonal relationships, which may take years to develop and tend to be highly local or organisation specific (Lee & Choi, 2003). Cultural KM resources is the range of shared principles, standards and morals, which are primarily possessed by the members of an organisation (Chuang, 2004). Organisations that have accumulated these KM resources can: (i) integrate the KM and business planning processes more effectively; (ii) develop reliable and innovative applications that support the business needs of the firm faster than competitors; and (iii) predict future business needs of the firm (Lee & Choi, 2003). According to Johannessen and Olsen (2003), KM resources offer the type of capabilities that are difficult to imitate.

C. Knowledge process capability

Knowledge processes defined through several steps, starting with knowledge creation followed by the use of knowledge, the conversion of knowledge, and the storage and retrieval of knowledge for further use (Seufert et al. 2004). Knowledge application is the deployment of the stored knowledge of the individual and organisation's memory and turning it into effective action (Gedam & Chauhan, 2010). While knowledge can be created and learned, it can also be forgotten when individuals or organisations do not remember the created knowledge or lose track of the acquired knowledge. Therefore, a storage area is needed to retain, organise, and retrieve organisational knowledge (Altarawneh et al, 2018).

Lee and Sukoco (2007) in their study asserted that knowledge process capability consist of four processes: Acquisition, Conversion and Application, and Protection. These variables were chosen because they represent the minimum yet complete sequence of knowledge process activities investigated in the exploration of the concept. The acquisition includes all of the management processes oriented to obtaining knowledge. Conversion is necessary to illustrate that knowledge must be made available. The application acknowledges that knowledge must be beneficial. Protection has not been generally studied, but must be included to signify the extreme importance knowledge holds about the competitive advantage of a firm. This study also measures the sub-construct of the knowledge process capability based on the Lee and Sukoco (2007) study.

Methodology

A questionnaire of 30 items was developed adapted from Chaung (2004), and Lee, and Sukoco (2007), to measure the knowledge management effectiveness using knowledge infrastructure capability (KIC) and knowledge process capability (KPC) as sub-constructs (see the Appendix for the questionnaire items). To measure the KIC, Chaung, (2004) reported the following Cronbach's a value for the measures, respectively; structural KM resources 0.816, cultural KM resource 0.819, technical KM resource 0.681, human KM resource 0.688. Lee and Sukoco (2007) measured KPC have reported the following Cronbach's a value for the measures, respectively; acquisition process 0.894, conversion process 0.951, and application process 0.912.

Respondents were asked to indicate (on a ten-point Likert scale ranging from "strongly disagree" to "strongly agree") their level of agreements on the statements. Data was collected from 316 employees in the headquarters of Jordanian banks. This sector was chosen because it was considered as knowledge accelerated industry. Also, the current market hi-tech companies such as banks must implement innovative business strategies, and invest vast resources in research and development to remain competitive in the market (Reychav and Weisberg, 2010). This makes KM an important concept for these firms to succeed.

Result Analysis

First of all, the researcher conducts descriptive statistics to find Min., Max., Mean and standard deviation of the items that used to measure the construct of Knowledge Management Effectiveness and its sub-constructs; Knowledge Infrastructure Capability (KIC) and Knowledge Process Capability (KPC), then Confirmatory Factor Analysis (CFA) was conducted using AMOS version 21 to validate and confirm the measurement model of the study. This analysis technique was used as a process of refining the measurement items to achieve reliability and validity for a confirmed readiness model. Once the results have shown the confirmed model, statistical analysis was applied to demonstrate the assessment status knowledge management effectiveness in the Jordanian banks.

A. Descriptive Statistics

Knowledge Infrastructure Capability was measured according to four constructs: Structural Knowledge, which formed from four items; Cultural Knowledge, which formed from four items; Technical Knowledge, which formed from five items; and Human Knowledge, which formed from four items. As shown in Table 1, the respondents revealed that their level of agreement with Structural Knowledge was average with mean score of 7.896 and the Cultural Knowledge was average with mean score of 7.952 while Technical Knowledge was average with mean score 7.625 and Human Knowledge was average with mean score of 7.951. The mean score of Structural Knowledge ranged from 7.41 to 8.11 and the standard deviation ranged from 1.557 to 1.689. As for the Cultural Knowledge, the items ranged from 7.82 to 8.25, the standard deviation ranged from 1.294 to 1.486, while the mean score of Technical Knowledge ranged from 7.47 to 7.76 and the standard deviation ranged from 1.726 to 2.018. Finally, the mean score of Human Knowledge ranged from 7.77 to 8.08 and the standard deviation ranged from 1.395 to 1.635.

Table 1: Knowledge Infrastructure Capabilities Mean Score

Dimension	Item	Min	Max	Mean	Std. Dev
Structural Knowledge		1	10	7.896	1.383
	Our organisation has structure helps employees to discover new knowledge (SK1).	1	10	8.02	1.602
	Our organisation has structure helps employees to create new knowledge (SK2).	1	10	8.11	1.557
	Our organisation has a reward system that encourages employees for knowledge sharing (SK3).	1	10	8.03	1.574
	Our organisation facilitates employees to exchange knowledge across different functional levels (SK4).	1	10	7.41	1.689
Cultural Knowledge		3.25	10	7.952	1.236
	Employees in the organisation where I work understand the importance of knowledge (CK1).	3	10	7.86	1.387
	In the organisation where I work Employees are valued based on their knowledge (CK2).	2	10	7.88	1.486
	In our organisation, workgroups are encouraged to interact with each other (CK3).	2	10	7.82	1.431
	The organisations where I work encourage employees to explore the knowledge (CK4).	4	10	8.25	1.294
Technical Knowledge		1	10	7.625	1.595
	In our organisation there are tools of knowledge-based services (TK1).	1	10	7.76	1.806
	In our organisation there are tools of knowledge-based processes (TK2).	1	10	7.64	2.018
	In our organisation, employees use technology to cooperate in achieving	1	10	7.47	1.991

	their tasks (TK3).				
	In our organisation, employees use technology to search for new knowledge (TK4).	1	10	7.57	1.825
	In our organisation, employees use technology to retrieve stored knowledge about its services and processes (TK5).	1	10	7.68	1.726
Human Knowledge		2.75	10	7.951	1.271
	In our organisation, employees understand their duties (HK1).	2	10	7.77	1.635
	In our organisation, employees have an idea about their colleague's duties (HK2).	3	10	8.08	1.395
	In our organisation, employees can make suggestions about colleagues' duties if needed (HK3).	3	10	8.03	1.433
	In our organisation, employees can communicate with their department members and others department's members (HK4).	3	10	7.92	1.454
Average mean Score of Knowledge Infrastructure Capability		7.843			

Knowledge Process Capability was measured according to three constructs: Acquisition Process, which formed from four items; Conversion Process, which formed from five items; and Application Process, which formed from three items. As shown in Table 2, the respondents revealed that their level of agreement with Application Process (average mean score 7.961) was higher than Conversion Process (average mean score 7.881) and Acquisition Process (average mean score 7.611). The mean score of Acquisition Process ranged from 7.47 to 7.76 and the standard deviation ranged from 1.806 to 2.018, as for the Conversion Process, the items ranged from 7.41 to 8.11 the standard deviation ranged from 1.557 to 1.689, while the mean score of Application ranged from 7.77 to 8.03 and the standard deviation ranged from 1.395 to 1.635

Table 2: Knowledge Process Capabilities Mean Score

Dimension	Item	Min	Max	Mean	Std. Dev
Acquisition Process		1	10	7.611	1.672
	Our organisation has processes for creating new knowledge from existing knowledge (AP1).	1	10	7.76	1.806
	Our organisation has processes for exchange knowledge with our business partners (AP2).	1	10	7.64	2.018
	Our organisation has processes for acquiring knowledge about new service within our sector (AP3).	1	10	7.47	1.991
	Our organisation has processes for acquiring knowledge about competitors within our sector (AP4).	1	10	7.57	1.825
Conversion Process		1	10	7.881	1.402
	Our organisation has processes for converting knowledge into the design of new service (CP1).	1	10	8.11	1.557
	Our organisation has processes for converting innovative knowledge into plans of action (CP2).	1	10	8.03	1.574
	Our organisation has processes for transporting organisational knowledge to individuals (CP3).	1	10	7.41	1.689
	Our organisation has processes for absorbing knowledge from individuals into the organisation (CP4).	1	10	7.98	1.592
	Our organisation has the process for integrating different sources and types of knowledge application process (CP5).	1	10	7.86	1.642
Application Process		2.6	10	7.961	1.306
	Our organisation has processes for utilising knowledge learned from employee's experience (ACP1).	2	10	7.77	1.635

	Our organisation quickly applies knowledge in the case of critical competitive needs (ACP2).	3	10	8.08	1.395
	Our organisation quickly applies knowledge in the problem-solving processes (ACP3).	3	10	8.03	1.433

B. CFA to Validate Knowledge Management Effectiveness

The purpose of the study is to validate the measurement model of knowledge management effectiveness which is second-order construct consists of two first-order constructs: knowledge infrastructure capability (KIC) and knowledge process capability (KPC). All of these constructs are considered as latent constructs. In the measurement model, validation procedure is called Confirmatory Factor Analysis (CFA) and must conducted for the latent constructs to find their Unidimensionality, Validity, and Reliability (Awang, 2015: Awang et al., 2015, 2018; Kashif et al., 2015, 2016; Mohamad et al., 2016, 2017, 2018; and Afthanorhan et al., 2017, 2017a, 2018, 2019).

According to Awang (2014, 2015), Awang et al. (2015, 2018), Yusof et al. (2017), and Mohamad et al. (2016, 2017, 2018), the measurement model of latent constructs needs to pass three types of validity namely Construct Validity, Convergent Validity, and Discriminant Validity. The Construct Validity is assessed through the Fitness Indexes of the Measurement Model, while the Convergent Validity is assessed through computing the Average Variance Extracted (AVE), and Discriminant Validity is assessed through developing the Discriminant Validity Index Summary.

As for the reliability, it is adequate for the research to estimate Composite Reliability (CR) since it reinstated the traditional method of computing the Cronbach Alpha for analysis using the Structural Equation Model (SEM) (Kashif et al., 2015, 2016; Noor et al., 2015; Yusof et., 2017, Aziz et al., 2016; Mohamad et al., 2016, 2017, 2018). The particular latent construct is supposed to be valid if its fitness indexes achieved the three Model Fit categories namely Absolute Fit, Incremental Fit and Parsimonious Fit (Awang et al., 2015, 2018; Kashif et al., 2015; 2016; Noor et al., 2015; Yusof et al., 2018). The fitness indexes and their respective thresholds are given in Table 3.

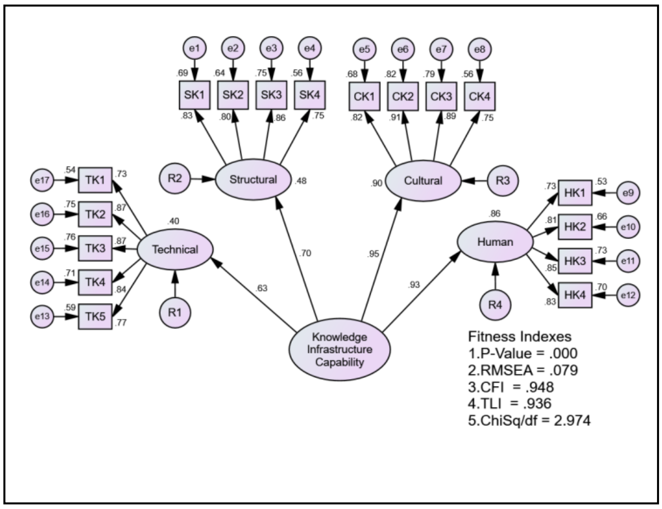
Table 3: The three categories of model fit and their level of acceptance

Name of category	Name of index	Level of acceptance
Absolute Fit Index	RMSEA	RMSEA < 0.08
	GFI	GFI > 0.90
Incremental Fit Index	AGFI	AGFI > 0.90
	CFI	CFI > 0.90
	TLI	TLI > 0.90
	NFI	NFI > 0.90
Parsimonious Fit Index	Chisq/df	Chi-Square/ df < 3.0

***The indexes in bold are recommended since they are frequently reported in literatures
Source: Awang (2015) and Awang et al. (2018)

As has been explained earlier, the Knowledge Infrastructure Capability is a second order construct with four sub-constructs or components as shown in Figure 1. In Figure 1, the fitness indexes for the whole construct, the factor loading for every sub-construct (component) as well as the factor loading for every item are presented. Thus, using the results in Figure 1, the researcher could assess the validity and reliability of this particular construct.

Figure 1. The CFA results for Knowledge Infrastructure Capability construct



The fitness Indexes in Figure 1 have met the threshold values as stated in Table 1. The Absolute Fit category namely RMSEA is 0.079 (achieved the threshold of less than 0.08), the Incremental Fit category namely CFI is 0.948 (achieved the threshold of greater than 0.90), and the Parsimonious Fit category namely the ratio of Chisq/df is 2.974 (achieved the threshold of less than 3.0). Thus, the measurement model of Knowledge Infrastructure Capability construct has achieved the requirement for Construct Validity (Awang, 2015;

Awang et al., 2015, 2018; Kashif et al., 2015, 2016; Noor et al., 2015; and Afthanorhan et al., 2018, 2019).

For the assessment of Convergent Validity, the study needs to compute the Average Variance Extracted (AVE). The construct achieved Convergent Validity if its AVE exceeds the threshold value of 0.5 (Awang, 2014, 2015; and Afthanorhan et al., 2017). As for assessing the Composite Reliability, the study needs to compute the CR, and its value should exceed the threshold value of 0.6 for this reliability to achieve (Awang et al., 2015, 2018). The AVE and CR for the main constructs and their respective sub-constructs are computed and presented in Table 4.

Table 4: The Average Variance Extracted (AVE) and Composite Reliability (CR).

Construct	Item	Factor Loading	CR (above 0.6)	AVE (above 0.5)
Knowledge Infrastructure Capability	Technical	0.63	0.884	0.664
	Structural	0.70		
	Cultural	0.95		
	Human	0.93		
Component				
Technical	TK1	0.73	0.910	0.669
	TK2	0.87		
	TK3	0.87		
	TK4	0.84		
	TK5	0.77		
Structural	SK1	0.83	0.885	0.658
	SK2	0.80		
	SK3	0.86		
	SK4	0.75		
Cultural	CK1	0.82	0.908	0.714
	CK2	0.91		
	CK3	0.89		
	CK4	0.75		
Human	HK1	0.73	0.881	0.650
	HK2	0.81		
	HK3	0.85		
	HK4	0.83		

As has been explained earlier, the Knowledge Process Capability is a second order construct with three sub-constructs or components as shown in Figure 2. In Figure 2, the fitness

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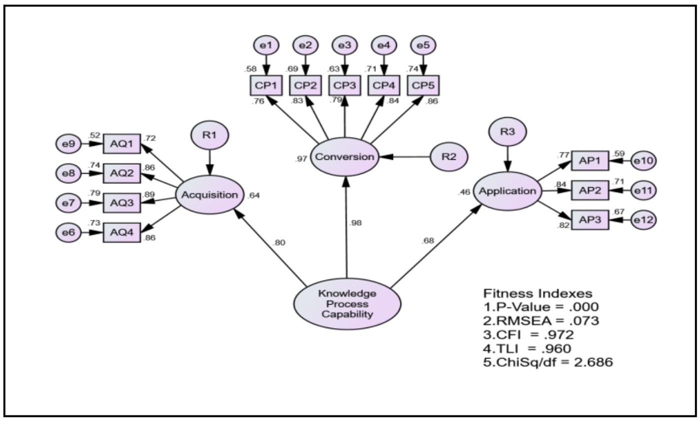
indexes for the whole construct, the factor loading for every sub-construct (component) as well as the factor loading for every item are presented. Thus, using the results in Figure 2, the researcher could assess the validity and reliability of this particular construct.

Figure 2. The CFA results for Knowledge Process Capability construct



The fitness Indexes in Figure 2 have met the threshold values as stated in Table 1. The Absolute Fit category namely RMSEA is 0.073 (achieved the threshold of less than 0.08), the Incremental Fit category namely CFI is 0.972 (achieved the threshold of greater than 0.90), and the Parsimonious Fit category namely the ratio of Chisq/df is 2.686 (achieved the threshold of less than 3.0). Thus, the measurement model of Knowledge Process Capability construct has achieved the requirement for Construct Validity (Awang, 2011; 2012; 2014; 2015; Awang et al., 2015, 2018; Kashif et al., 2015, 2016; Noor et al., 2015; and Afthanorhan et al., 2019).

For the assessment of Convergent Validity, the study needs to compute the Average Variance Extracted (AVE). The construct achieved Convergent Validity if its AVE exceeds the threshold value of 0.5 (Awang, 2014, 2015; and Afthanorhan et al., 2019). As for assessing the Composite Reliability, the study needs to compute the CR, and its value should exceed the threshold value of 0.6 for this reliability to be achieved (Awang et al., 2015, 2018). The AVE and CR for the main constructs and their respective sub-constructs are computed and presented in Table 5.

Table 5: The Average Variance Extracted (AVE) and Composite Reliability (CR).

Construct	Item	Factor Loading	CR (above 0.6)	AVE (above 0.5)
Knowledge Process Capability	Acquisition	0.80	0.866	0.688
	Conversion	0.98		
	Application	0.68		
Component				
Acquisition	AQ1	0.72	0.902	0.697
	AQ2	0.86		
	AQ3	0.89		
	AQ4	0.86		
Conversion	CP1	0.76	0.909	0.667
	CP2	0.83		
	CP3	0.79		
	CP4	0.84		
	CP5	0.86		
Application	AP1	0.77	0.852	0.657
	AP2	0.84		
	AP3	0.82		

Conclusion & Future Work

This study provides research results through analysis of knowledge management effectiveness constructs. Measurements adopted are based on two sub-constructs: KIC, measured by four dimensions; Structural KM resources, Cultural KM resources, Technical KM resources, and Human KM resources (Chaung, 2004). KPC is measured by three dimensions: acquisition processes, conversion processes and application processes (Lee and Sukoco, 2007).

Findings indicated that the revised model is reliable and valid after different phases in the analysis process using CFA were conducted. The revised model has shown the importance of all factors of KIC namely, structural KM resource, cultural KM resource, technical KM resource, and human KM resource. Similarly for all factors of KPC namely acquisition process, conversion process and application process. Based on the revised model developed, analysis of KM effectiveness in the Jordanian banks has also pointed towards a positive direction. This means employees are willing to adopt the KM effectiveness of both infrastructure and capability. While KM being important contributors to success in organisations, has been heavily misunderstood with the huge investment in information technology infrastructure.

Undeniably, various KM initiatives require a significant amount of cost and commitment by organisations. Many organisations ended up failing to benefit from KM investments due to lack of understanding among business executives. Therefore, it is advisable that organisations attempt to assess their KM before embarking on actual investments and implementation of various possibly expensive KM-related activities, infrastructures, and processes. This, therefore, should justify the needs for better understanding and more expansion of research in KM effectiveness through knowledge infrastructure and knowledge process through organisations.

Therefore, the revised and validated instruments developed from the results of this study should be useful in assessing KM effectiveness among organisations. Also, being not a well-defined concept, the research community can consider this attempt as a threshold in KM effectiveness and should continue to improve the quality of the measurements through more empirical research in different settings. Future work requires focusing more on the full model of KM effectiveness by looking into contributing factors or antecedents of the intention to get involved in the KM process concept. The extent of willingness to be involved in various KM processes and activities among employees can be attributable to factors such as existing organisational culture, structure, IT infrastructure, and various other human attributes.

Given the importance of KM in organisations as illustrated earlier, the results are also expected to provide sound measures of KM effectiveness from the behavioural perspective before organisations can embark on expensive and costly KM initiatives. The indicators also allow organisations to evaluate and understand how far the employees perceive and understand the concept of KM and willing to be part of the process. The research provides a new perspective in understanding KM effectiveness in organisations from the behavioural perspective. The measures acquired from the research will contribute significantly to future studies by linking them with various other contributing factors of KM effectiveness such as technological, organisational, and individual perspectives.

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