MEASURING KNOWLEDGE MANAGEMENT IN SUPPLY CHAINS: A REVIEW AND PROPOSAL

Liang Chen, Paul and Virginia Engler College of Business, West Texas A&M University, Canyon, TX 79016 West Texas A&M University, lchen@wtamu.edu

ABSTRACT

Knowledge management (KM) in supply chains (SC) involves numerous specific activities such as knowledge creation and application. This study first reviews over 30 different measurements of KM and observes three common problems, which raise a need for creating a new measurement. Driven by knowledge chain theory (KCT), this study proposes measuring KM using nine KCT items and tests this new measurement in the setting of supplier development. Using a survey of SC professionals, this study examines reliability and validity of the new measurement from both buying and supplying firms and shows that the first-order measurement model works better.

Keywords: Knowledge Chain Theory, Knowledge Management, Supply Chains, Supplier Development

INTRODUCTION

Knowledge management (KM) is playing an increasing role in creating and maintaining competitiveness of any organizations, even in the age of data analytics (Lee et al., 2016; Ekambaram et al., 2018; Mahdi et al., 2019). As a standalone field or domain, KM has been intensively studied (Holsapple & Singh, 2003). In a broader scope, KM has been often studied as a single construct or a combination of multiple interrelated constructs to examine the relationship between KM and many other constructs such as job satisfaction, innovation, organizational effectiveness, and organizational climate (Gold et al., 2001; Chen & Huang, 2007; Kim et al., 2014; Mao et al., 2018). Accordingly, KM has been measured in order to empirically test those relationships.

However, there are multiple practical challenges to measure KM correctly and comprehensively. First of all, KM has been defined and then measured in many different and inconsistent ways. For example, Hult (2003) explicitly defines KM as "the organized and systematic process of generating and disseminating information, and selecting, distilling, and deploying explicit and tacit knowledge to create unique value that can be used to achieve a competitive advantage in the marketplace by an organization" (p. 190), while Duffy (2000) briefly define KM as "the process that drives innovation by capitalizing on organizational intellect and experience" (p.64). Accordingly, they measure KM in different ways. Secondly, KM includes many classes of activities such as knowledge acquisition, generation, and externalization, which have been named inconsistently across studies. Thirdly, each class of KM activities comprises specific activities and therefore such a hierarchical structure increases measurement cost such as a survey with many

items and/or a large sample size in the data collection. For example, Duffy (2000) uses 56 items and Darroch (2003) uses 59 items to measure KM. If a researcher adopts their KM measurement, s/he will have to design a quite long survey, especially when some other constructs are also measured in the same research. Typically, a longer survey yields a lower response rate (Deutskens et al., 2004).

This study attempts to measure KM from Knowledge Chain Theory (KCT), which is drawn from the KM ontology (Holsapple & Joshi, 2004). KCT identifies and characterizes five classes of primary KM activities (aka, knowledge chain activities) that organizations perform and four classes of secondary activities that capture managerial factors influencing and governing the conduct of the primary activities (Holsapple & Jones, 2004, 2005; Holsapple & Singh, 2003). KCT provides a comprehensive, multi-level, and generic view of KM dimensions or activities, so it is considered as an appropriate framework to measure KM.

As a starting point, this study uses the five primary and four secondary knowledge chain activities to measure KM. The new instrument was tested and validated via a survey of experienced supply chain professionals, who reported knowledge chain activities from both buying and supplying firms in their training and assistance programs.

KNOWLEDGE CHAIN THEORY

In order to explain how KM activities occurring in KM episodes result in increased organizational competitiveness, Holsapple and Singh (2003) draw from the KM ontology and advance the Knowledge Chain Theory (KCT). Analogous to Porter's value chain theory, KCT identifies and characterizes five classes of primary KM activities (aka, knowledge chain activities) that organizations perform. These involve manipulation of knowledge resources. There are also four classes of secondary activities that capture managerial factors influencing and governing the conduct of those manipulation activities (Holsapple & Jones, 2004, 2005; Holsapple & Singh, 2001). The five classes of primary activities are knowledge acquisition, knowledge selection, knowledge generation, knowledge assimilation, and knowledge emission and the four classes of secondary activities are knowledge measurement, knowledge control, knowledge coordination, and knowledge leadership. In total, the nine distinct, generic classes of activities are available for an organization to perform in the course of managing its knowledge resources in an effort to attain better performance or competitive advantage. Empirical studies have found that any of the nine knowledge chain activities can be performed in ways that enhance organization competitiveness (Holsapple & Wu, 2011).

The five primary classes of KM activities represent distinct processes within a KM episode and, together, facilitate knowledge flows in an organization (Holsapple & Joshi, 2004). A knowledge acquisition activity receives knowledge from the external environment, which includes customers and suppliers, and then delivers the acquired knowledge to assimilation, generation, and/or emission activities. Obtaining knowledge from an entity's knowledge resources, a knowledge selection activity delivers the selected knowledge to generation, assimilation, and/or emission activities. Upon receiving knowledge flows from knowledge selection or acquisition, a knowledge generation activity may deliver the knowledge it derives or discovers to assimilation and/or emission activities. A knowledge assimilation activity delivers knowledge to the entity's knowledge resources, subject to considerations such as filtering, validity, and security, after it receives knowledge flows from the knowledge acquisition, selection, and/or generation activities.

Knowledge emission receives knowledge flow from knowledge selection, acquisition, and/or generation activities and, then, delivers it to targets in the environment.

Knowledge flows into a firm, for instance, when its employees attend a lean six sigma course (knowledge acquisition), and then those employees may choose appropriate quality control skills for future use (knowledge selection), or offer an in-house training (knowledge assimilation) or create new knowledge by shaping it to the firm's context (knowledge generation), or share knowledge with suppliers to facilitate inter-organizational collaboration (knowledge emission).

The four classes of secondary activities represent managerial influences in the KM ontology. "The objective of KM within and across organizations is to ensure the right knowledge is available in the right forms to the right processors at the right times for the right cost in order to secure the right level of organizational performance" (Holsapple & Jones, 2005, p. 4). This objective cannot be accomplished without appropriate execution of secondary KM activities because they enable an organization to successfully conduct KM manipulation activities through managing knowledge resources, knowledge processors, knowledge flow conditions, and dependencies among KM activities. Whereas knowledge leadership establishes enabling conditions for fruitful execution of various KM manipulation activities, the other three classes contribute to establishing these conditions. For instance, knowledge coordination activities ensure that proper resources are brought to bear at appropriate times and integrate knowledge processing with organization's operations.

Overall, KCT contributes to the KM literature by identifying nine distinct but relevant classes of KM activities, developing a typology of activity types for each class, and illustrating how knowledge chain activities lead to organization competitiveness. Furthermore, KCT provides a comprehensive list of KM activities, which can be used to measure the construct KM.

A REVIEW OF KM MEASUREMENTS

KM has been defined and measured in many different ways. Studies focusing on the development of KM measurement usually include many items. For example, Darroch (2003) defines KM as "the process that creates or locates knowledge and manages the dissemination and use of knowledge within and between organizations" (p.41) and presents KM as a third-order construct, which is measured by three second-order factors, knowledge acquisition, knowledge dissemination, and responsiveness to knowledge. She originally includes 97 items in her survey, and then 59 items remains in the final measurement model. Lee et al. (2005) describe KM as "the management of the environment, making knowledge flow through the different phases of its life cycle" (p.472) and develop a KM performance index. In their index, KM is measured by seven factors (33 items in total): knowledge utilization, knowledge accumulation, knowledge internalization by education opportunity and organizational learning, knowledge internalization by task-related knowledge, knowledge sharing, knowledge creation by task understandings, and knowledge creation by information understandings.

Many studies examine the impact of KM and measure KM in a varying way. Gold et al. (2001) examine the effectiveness of KM from the perspective of organizational capabilities and describe the conversion from information management to KM as "a complex undertaking involving the development of structures that allow the firm to recognize, create, transform, and distribute knowledge" (p. 186). Accordingly, they suggest that KM capabilities consist of two components: infrastructure and process capabilities, each of which is measured as a second-order factor (56 items in total). Sabherwal and Becerra-Fernandez (2003) describe KM as "doing what is needed to get the most out of knowledge resources" (p.227) and thus examine KM effectiveness from a

process perspective. Specifically, they measure KM using its four processes, internalization, externalization, socialization, and combination (15 items in total). They find that the four processes have different impacts on perceived individual-level, group-level, and organizational-level KM effectiveness. Darroch (2005) uses this measurement model developed in her previous study (59 items) to investigate the relationship between KM and innovation and firm performance.

Recently, Reich et al. (2012) describe KM in a project as "the management activities required to source the knowledge stock, create the enabling environment, and manage the knowledge practices to result in an aligned set of project-based knowledges" (p.665). Accordingly, they conceptualize KM as a three dimensional concept comprising knowledge stock, enabling environment, and knowledge practices (15 items in total) and then examine their impacts on the quality of project-based knowledges and alignment of project-based knowledges. Later, they use the same measurement method to extend their model to project management performance and project performance. Kim et al. (2014, p. 399) define KM strategy as "a logical plan with regard to firms' decisions about the types and origins of knowledge to create and sustain a competitive advantage" and examine the effect of KM strategies on KM performance from a contingency perspective. They develop single-item measures for KM strategies by combining two KM dimensions (4 items in total): knowledge type and knowledge origin. Accordingly, they include four KM strategies: external codification, internal codification, external personalization, and internal personalization. Chen and Fong (2015, p. 435) state that the purpose of KM is to "develop a special dynamic capability" (namely, KM capability), which "aligns a firms' knowledge resources with the needs of the changing market". They uses four learning routines (knowledge identification, acquisition, dissemination, utilization) and two governance mechanisms (organizational mechanisms and technological mechanisms) to measure KM capability and examine how KM capability affects business performance. More recently, Fernandez et al. (2018) inspect the influence of KM on a firm's performance and competitive advantage in Spanish pharmaceutical retail sector. In their model, KM is measured by six items such as staff training.

Among a few studies examine the determinants of KM, Chen and Huang (2007) investigate the effects of organizational climate and structure on knowledge management from the social interaction perspective. In their study, KM is measured by two factors: knowledge sharing and application (5 items in total). Singh (2008) examines the influence of leadership styles on KM practices, which are measured by five factors (30 items in total): knowledge identification & creation, knowledge collection & capture, knowledge storage & organization, knowledge sharing & dissemination, and knowledge application & use.

Furthermore, the construct KM has been examined as a mediator in some studies. Noruzy et al. (2013, p. 1075) define KM as "the mechanisms that creates and stores data to increase an organization's response time and create innovation through the collection, storage, and study of organizational information". In their study, KM serves as a mediator between transformational leadership and organizational performance and it is measured by four items such as knowledge integration and knowledge conversion. In Liu and Lee (2015), KM plays a mediating role in the relationship between social capital and vendor's entrepreneurial orientation and KM is KM is measured as a second-order factor, including two factors (5 items in total): knowledge diversity and knowledge application. Similarly, Mao et al. (2016) find that KM capability acts as a significant mediator of the relationships between two types of IT resources and competitive advantage. In their measurement model, KM capability is measured by seven items such as generating new knowledge from existing knowledge.

In sum, our review of extant KM measurements reveal three findings. First, the construct KM plays different roles: some papers focus on the development and validation of KM measurement, while others focus on impacts, determinants, or mediation effects of KM. Second, the construct KM has been measured in various and inconsistent ways: some studies measure it as a first-order factor with a few items, while others measure it as a higher-order factor or multiple factors using dozens of items. Third, previous measurements have been rarely adopted by subsequent studies.

A PROPOSAL OF KCT-BASED KM MEASUREMENT

We map all the aforementioned 31 measurements to the KM dimensions derived from KCT. Our mapping reveals a few observations. First, most of existing measurements cover three to five primary knowledge chain activities and one secondary knowledge chain activity. Only one study covers all the nine KCT activities using 56 items. Second, among all the nine knowledge chain activities, knowledge acquisition and assimilation have been intensively covered in extant measurements. Third, compared with the primary knowledge chain activities, secondary activities have been overlooked by many KM measurement models.

KCT can serve as a good guideline to measure KM for three reasons. First of all, KCT provides a comprehensive view of KM dimensions. KCT is developed from a comprehensive foundation because all the nine classes of KM activities in KCT are generated based on both a Delphi-study of international KM experts and a comprehensive literature review (Holsapple & Singh, 2001; Holsapple and Jones, 2004, 2005). In addition, our review of extant KM measurements reveals that all of those items are subsumed in the nine dimensions in KCT, demonstrating the comprehensiveness of KCT.

Secondly, KCT presents a multi-level typology of KM activities. At the top, it includes five classes of primary activities and four classes of secondary activities, each of which is briefly and clearly described. At the middle, there are 32 and 29 distinct activity types for the five primary and four secondary activity classes, respectively (Holsapple & Jones, 2004, 2005). For instance, knowledge assimilation includes four types such as formal internal publishing and informal internal interaction. At the bottom, each activity type consists of consolidated sample activities. For instance, formal internal interaction includes sample activities such as in-house training and participating in intra-organizational communities of practice. Such a hierarchical typology determines the number of measurement items: the higher level in the typology, the smaller number of measurement items. Therefore, it gives researchers a bigger flexibility to determine the number of items to measure KM.

Thirdly, KCT identifies distinct and generic classes of KM activities, which can be applied to various contexts. As mentioned above, the typology of knowledge chain activities is developed from a Delphi-study of international KM experts and a comprehensive literature review, so it is a generic framework. In addition, KCT has been empirically examined at both organizational and inter-organizational levels, further demonstrating its general applicability (Ponis & Koronis, 2012; Tseng, 2012).

In sum, KCT satisfies all the three requirements for a good framework to measure KM, which further motivates us to measure KM from the KCT perspective. We choose the top level of as a starting point and develop the KM measurement theoretically from KCT. This new measurement is empirically validated by an online survey of supply chain professionals in the United States. We perform both exploratory factor analyses and confirmatory factor analyses from both buyer and supplier sides and compare the first- and second-order factor measurement models of KM. Our

results show that the first-order factor measurement model works better. However, such comparisons are recommended to perform in the future using a bigger sample size and/or a different context.

DISCUSSION AND CONCLUSIONS

This study reviews the extant KM instruments and reveals that most of them do not comprehensively cover all the KM dimensions. Driven by KCT, this study develops a new instrument in the context of supplier development. This new instrument is further tested and validated by a sample of supply chain professionals from United States. Both exploratory and confirmatory factor analyses are performed and our instrument demonstrates high reliability and validity. Furthermore, both supplier and buyer data support that the first-order measurement model outperforms the second-order model.

Our study makes several main theoretical contributions. First, it contributes to KM literature by reviewing the existing KM measurements, revealing that a comprehensive measurement is needed, and proposing such a measurement. Our new KM instrument provides an inclusive view of knowledge management, which will help organizations capture all the operational and managerial activities and better examine both determinants and consequences of KM in SCM. Our study also contributes to SCM practice by demonstrating that both primary and secondary knowledge chain activities should be considered when measuring KM and that KM activities at both buying and supplying firms must be measured.

This study is not without limitations, most of which can be addressed in the future research. As discussed previously, KCT has identified 61 distinct sub-activities under the nine activity classes, so it will be valuable attempt to use all those sub-activities to measure KM. Second, we measured KM in the context of supplier development, so the future research can consider replicating the study in different contexts.

REFERENCES

Chen, C.-J., & Huang, J.-W. (2007). How organizational climate and structure affect knowledge management—The social interaction perspective. *International journal of information management, 27*(2), 104-118.

Chen, L., & Fong, P. S. (2015). Evaluation of knowledge management performance: An organic approach. *Information & Management, 52*(4), 431-453.

Darroch, J. (2003). Developing a measure of knowledge management behaviors and practices. *Journal of knowledge management, 7*(5), 41-54.

Darroch, J. (2005). Knowledge management, innovation and firm performance. *Journal of knowledge management, 9*(3), 101-115.

Duffy, J. (2000). Knowledge management: to be or not to be? *Information management, 34*(1), 64.

Fernandez, A. I., Lara, P. R., Ugalde, M. C., & Sisodia, G. S. (2018). Distinctive competencies and competency-based management in regulated sectors: A methodological proposal applied to the pharmaceutical retail sector in Spain. *Journal of Retailing and Consumer Services, 42*, 29-36.

Gold, A. H., Malhotra, A., & Segars, A. H. (2001). Knowledge management: An organizational capabilities perspective. *Journal of management information systems, 18*(1), 185-214.

Holsapple, C., & Jones, K. (2004). Exploring primary activities of the knowledge chain. *Knowledge and Process Management, 11*(3), 155-174.

Holsapple, C., & Jones, K. (2005). Exploring secondary activities of the knowledge chain. *Knowledge and Process Management, 12*(1), 3-31.

Holsapple, C., & Singh, M. (2001). The knowledge chain model: activities for competitiveness. *Expert systems with applications, 20*(1), 77-98.

Holsapple, C., & Singh, M. (2003). The knowledge chain model: activities for competitiveness *Handbook on knowledge management* (pp. 215-251): Springer.

Holsapple, C. W., & Joshi, K. D. (2004). A formal knowledge management ontology: Conduct, activities, resources, and influences. *Journal of the American Society for Information Science and Technology, 55*(7), 593-612.

Holsapple, C. W., & Wu, J. (2011). An elusive antecedent of superior firm performance: The knowledge management factor. *Decision Support Systems, 52*(1), 271-283.

Hult, G. T. M. (2003). An integration of thoughts on knowledge management. *Decision sciences, 34*(2), 189.

Kim, T. H., Lee, J.-N., Chun, J. U., & Benbasat, I. (2014). Understanding the effect of knowledge management strategies on knowledge management performance: A contingency perspective. *Information & Management, 51*(4), 398-416.

Lee, K. C., Lee, S., & Kang, I. W. (2005). KMPI: measuring knowledge management performance. *Information & Management, 42*(3), 469-482.

Liu, C.-H., & Lee, T. (2015). Promoting entrepreneurial orientation through the accumulation of social capital, and knowledge management. *International Journal of Hospitality Management, 46*, 138-150.

Mao, H., Liu, S., Zhang, J., & Deng, Z. (2016). Information technology resource, knowledge management capability, and competitive advantage: The moderating role of resource commitment. *International journal of information management, 36*(6), 1062-1074.

Noruzy, A., Dalfard, V. M., Azhdari, B., Nazari-Shirkouhi, S., & Rezazadeh, A. (2013). Relations between transformational leadership, organizational learning, knowledge management, organizational innovation, and organizational performance: an empirical investigation of manufacturing firms. *The International Journal of Advanced Manufacturing Technology, 64*(5-8), 1073-1085.

Ponis, S. T., & Koronis, E. (2012). A knowledge management process-based approach to support corporate crisis management. *Knowledge and Process Management, 19*(3), 148-159.

Reich, B. H., Gemino, A., & Sauer, C. (2012). Knowledge management and project-based knowledge in it projects: A model and preliminary empirical results. *International Journal of Project Management, 30*(6), 663-674.

Sabherwal, R., & Becerra-Fernandez, I. (2003). An empirical study of the effect of knowledge management processes at individual, group, and organizational levels. *Decision sciences, 34*(2), 225-260.

Singh, S. K. (2008). Role of leadership in knowledge management: a study. *Journal of knowledge management, 12*(4), 3-15.

Tseng, S.-M. (2012). Correlations between external knowledge and the knowledge chain as impacting service quality. *Journal of Retailing and Consumer Services, 19*(4), 429-437.