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Exploring the relationships between knowledge networks/mobilisation and lean performance in agri-food supply chain context: a fuzzy-set qualitative comparative analysis

Huilan Chen, Shaofeng Liu, University of Plymouth, UK

Festus Oderanti, University of Hertfordshire, UK

Oluwafemi Oyemomi, Northumbria University, UK

Abstract

Knowledge network/mobilisation and lean performance have been most often discussed in an isolated manner in generic context in literature. Few studies currently exist that focus on their relationship in supply chain management. This study investigates the relationships between knowledge network types/ mobilisation approaches and successful lean performance outcome using fuzzy-set qualitative comparative analysis (fsQCA) technique. Based on empirical data collected from 32 cases in agri-food supply chains (SCs), the results reveal model routes to each specific measure for lean SC performance. The findings also indicate that no one single antecedent is sufficient or necessary for high lean performance. The study offers implications for the development of more mature and reliable knowledge communication channels and mobilisation strategies. The findings also have great potential in helping make the right SC decisions for improving lean performance in agri-food industry.

Keywords: Knowledge network; Knowledge mobilisation; Agri-food SC; Lean performance; Fuzzy-set QCA

1. Introduction

The agri-food industry plays a significant role in a nation's economy due to its export potential, procurement of income and employment. However, a number of changes have occurred in the last few decades in this sector. First, because of demographic developments (that is, the ageing population, more double-income families) consumers are more than ever interested in having fresher food with higher added values. Second, as a consequence of globalisation, the entrance of new competitors and the existing of stricter regulations and laws for food safety and environment-friendly production, raise demands on management (Van Der Vorst & Beulens, 1999). As such, a typical agri-food supply chain (SC) is considered as a complicated network which contains a number of entities linked from "farm to fork", such as farmers, input suppliers, co-operatives, pack-houses, transporters, exporters, importers, wholesalers, retailers and finally consumers (Doukidis, Matopoulos, Vlachopoulou, Manthou & Manos, 2007).

When products move through SC partners and eventually to customers, it will incur some cost. Hence, to reduce cost and waste, lean performance has played an important role over the years and significant success all over the world has been reported (Womack & Jones, 1996). However, applying lean performance in agri-food SC is an under-addressed topic because of a number of challenges, including the lack of understanding of the nature of waste and lack of mature means of reducing waste (Folinas, Aidonis, Triantafillou & Malindretos, 2013). Subsequently, there is little report on best practices and lessons learnt on the topic of assessing lean performance in agri-food industry.

As agri-food SC is a relatively long chain, knowledge exchange with each partner is so vital which can shorten the delivery time and make a quick response to market. At this point, knowledge management which contributes to the effective usage of knowledge and knowledge flow has a valuable influence on agri-food supply chain management (Kahn, Maltz & Mentzer, 2006; Asgari, Nikbakhsh, Hill & Farahani, 2016). Hence, this study is concerned with knowledge flow and sharing across stakeholders in agri-food industry and mainly focused on knowledge network and mobilisation in order to achieve lean performance, by employing fuzzy set qualitative comparative analysis (fsQCA).

FsQCA is a method that uses combinatorial logic, fuzzy set theory and Boolean minimisation to work out what combination of casual conditions lead to a given outcome (Schneider, Schulze-Bentrop & Paunescu, 2010; Ragin, 2000; Ragin, 2008). This method relaxes the limitation of sample size and thereby allows to work with small to medium-sized samples (n=10 to 50) (Rihoux and Ragin, 2004). Compared to conventional QCA, it makes possible to use continuous or interval-scare variables, although the variables need to be calibrated. This calibration consists of assigning the variables a value between 0.0 and 1.0 according to their degree of membership (Woodside & Zhang, 2012).

This study explores how knowledge network/mobilisation affects lean performance which can provide important integration for knowledge management and SC practice using the method of fsQCA. Section 2 of this paper reviews relevant work and presents a conceptual model. Section 3 outlines the research method. Section 4 reports the empirical results. Section 5 provides a discussion and concludes with important implications and suggestions for future research.

2. Literature review

Knowledge management is a well-developed area which has been widely practised in SC due to the fundamental nature of knowledge for problem solving and ensuring strategy development (Asgari et al., 2016; Kahn et al., 2006). Within this context, SC knowledge can be defined as the use of knowledge resources obtained from SC partners for economic gain (Craighead, Hult & Ketchen, 2009).

At the early stage of knowledge management, the term "knowledge worker" was widely used in organizations to stress the creation of ideas, which brings sharp contrast to the manual workers (Drucker, 1992; Oyemomi, Liu, Neaga & Alkhuraiji, 2016). By the middle of 2000s, knowledge workers accounted for 42 percent of all employment in the UK (Brinkley, 2006). Hence, the term "knowledge economy" has appeared to emphasize an economy that is driven by knowledge rather than physical capital, natural resources or low skilled labour. However, in SC context, despite the fact that SC partners reinforce their relationship and manage information sharing to achieve the competitive advantage of knowledge flow for the SC, as a whole, there are still huge barriers that knowledge flow can be adapted to SCs due to the lack of mature and reliable knowledge communication channels and mobilisation strategies, even though the importance of knowledge networks and mobilisation requirements have been recognized (Liu, Moizer, Megicks, Kasturiratne & Jayawickrama, 2012). Knowledge flow among organizations would help the whole SC to maximize total revenue and improve SC efficiency and knowledge sharing success rate (Outahar, Nfaoui & EL Beqqali, 2013).

Researchers have focused on performance measures of SC from different dimensions. Behrouzi and Wong (2011) reveal time-based performance of SC and do not include losses and other wastes: quality, cost, time and delivery. Leong, Snyder and Ward (1990) claim that the key performance metrics can be defined in terms of quality, delivery speed, delivery reliability, cost (price) and flexibility. In addition, Neely, Gregory and Platts (2005) point out that the generic terms quality, cost, time and flexibility encompass a variety of different dimensions.

Overall, few studies focus on how knowledge network/mobilisation affects SC performance, especially applying lean philosophy and practice into SC. To fill the research gap, this study proposes a Lean-KMob model, as shown in Figure 1, to explore the various combination relationships between knowledge network/mobilisation and lean performance.

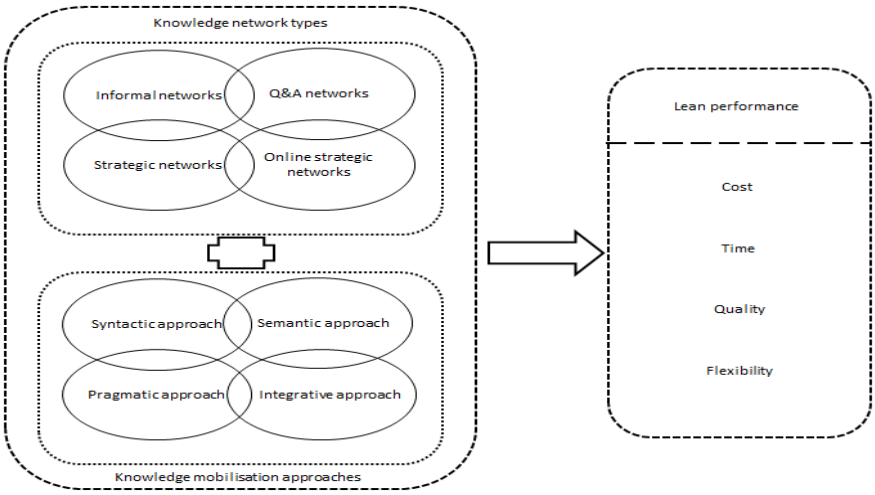

Figure 1. The Lean-KMob model

2.1 Knowledge networks

In today's competitive and dynamic marketplace, organizations are facing new challenges, including collaborative learning, organizational learning, and knowledge transfer and sharing (Andersson, Holm & Johanson, 2007). Knowledge networks help to meet the challenges. A strategic knowledge network can keep organizations sustainable. The term of networks means connection, linkage, action, brokering and intermediaries that require systematic action to build strategic knowledge networks for knowledge mobilisation (Hislop, Newell, Scarbrough & Swan, 2000; Alkhuraiji, Liu, Oderanti & Megicks, 2016). Knowledge network is considered as expert institutions sharing the common interests and concerns, and attempting to enhance the understanding of an intent knowledge topic, and then deliver solutions for some particular decision problems (Creech, 2001). In order to make sure the availability of connections, knowledge networks in multi organizations need a cohesion within people, a knowledge path, a good policy and organizational structures, and knowledge infrastructure (Alkhuraiji et al., 2016).

According to Verburg and Andriessen (2011), knowledge networks have been classified into four types based on two dimensions of formalization and interaction, which can be described in the following ways: *Informal networks* refer to the group of employees with a common area of interest, closely related to their work, having substantial interaction involving shared concepts. People in these networks are to learn from each other. This type of knowledge network is not very formalized, but with high interaction. *Q&A networks* with medium interaction and low level of formalization and can only solve the certain practical problems. *Strategic networks* and *online strategic networks* generally consist of group of expert knowledge professionals who can bridge the gaps between experience sharing individuals and the organization, even the SC partners. Some of these networks have much interaction in face to face meetings or via video conference, requiring intensive preparation, member selection, leadership team support and coordination.

As a whole, creating a well-defined knowledge network would help to maintain the integration of knowledge into the business operations and most especially, when business units are unconnected to the internal and external knowledge. For example, some knowledge providers may make a list to prove isolated knowledge as a commercial secret, on the other hand, from knowledge receivers' perspective it wastes their time to search for the isolated knowledge. Therefore, common practice supported by knowledge network is quite vital nowadays.

2.2 Knowledge mobilisation

Knowledge mobilisation addresses how external knowledge (outside of the organization) is sought out and combined with internal knowledge to create and utilise new knowledge. Knowledge mobilisation emphasizes purpose, for instance, how to meet the needs of customers and how one brings in the knowledge of others. It recognizes that organizing one's own intellectual capital does not necessarily lead to innovation or change, but the hint in the concept is the need for working relationships with others (Creech, 2004).

Jashapara (2011) comes up with the term knowledge mobilisation indirectly from the connection of people, organizations, resources, culture and the community of practice. To be specific, it includes the differences between organizational culture and organizational climate, issues regarding building communities of practice, embedding knowledge management

technology into a desired culture, cultural typologies and the techniques and strategies on knowledge sharing (Alkhuraiji, Liu, Oderanti, Annansingh & Pan, 2014).

However, the barriers to more effective knowledge mobilisation are multiple and real. They include lack of sufficient high quality evidence, unavailability of evidence when it does exist, lack of interest among users in evidence, low trust in the evidence, lack of skills in finding and interpreting evidence, lack of infrastructure to support research use. So the approaches of knowledge mobilisation are scheduled to go forward. The knowledge mobilisation approaches based on the nature of knowledge sharing activities underpinned by the knowledge networks using the knowledge spaces (Ba), depending on the type of knowledge (tacit or explicit) shared (Carlile, 2004; Nonaka & Konno, 1998; Oyemomi et al., 2016). *A syntactic approach* refers that when knowledge is transferred according to a common lexicon, domain specific knowledge can be managed across the organizations. When novelty appears, new differences and dependencies need to be identified, *a semantic approach* leads to translate domain specific knowledge in order to establish common meanings. If a semantic approach does not respond the problem, *a pragmatic approach* is coming into effect. It needs to negotiate and transform both the common knowledge and domain specific knowledge used in the past to create new knowledge (Jantsch, 1980; Shannon & Weaver, 2002; Hara & Sanfilippo, 2016). *An integrative approach* is knowledge reasoning based on the theory of Bayesian network, has become an effective approach for knowledge creation and transfer and decision support systems (Popescul, Pennock & Lawrence, 2001; Berchialla, Scarinzi, Snidero & Gregori, 2010; Pan,Wang, Bi, Shan & Xu, 2014).

2.3 Lean SC performance

SC as a concept has been coined in 1980s and defined as a chain or network that includes the process of providing raw materials, manufacturing, distributing, retailing and selling the products or services to final customers (Christopher, 2005). There has been some important evolution for SC. Researchers are not only taking the supply side (the upstream of SC) seriously, but also paying more attention on the demand side (closer to customers). Currently, the term SC is accepted to be used for both supply chain demand sides for the entire chain.

Supply chain management (SCM) is the term that has been used to describe the functions of managing SC activities and the main aim of it is to realize the optimized efficiency during the circulation of commodities. Talking about the benefits of SCM, it is essential to point out the customers' value. Traditionally, economic value is witnessed as one perspective of the customer value, which aims at the lowest cost; the second perspective is market value, referring to the convenient product or service variety and choice; the third one is relevancy value, involving correct activities acknowledged on the base of the previous two values (Bowersox, Closs & Cooper, 2002). Achieving the three values requires an integrative management of the whole supply chain and SCM integrates supply chain demand management within and across organizations.

Lean is the key to the success of Japanese corporation, Toyota, in the late 20s century (Alabduljabbar & Callender, 2012). After decades of development, lean has expanded to further theories and was summarized into lean thinking. The core idea of lean thinking is eliminating waste by organizing human activities and operation processes, creating more value with less investment, for instance, labour, equipment, time and space (Womack & Jones, 2010). Lean SC was recognized there are several benefits as described by Li, Ragu-Nathan and Rao (2006) and Gereffi (1999b): improved quality, reduced cost, improved delivery, high flexibility, reduced shortage and so forth.

In order to achieve lean SC, it is essential to develop performance metrics to fully integrate SC partners to maximise effectiveness and efficiency (Gunasekaran, Patel & Mcgaughey, 2004). The term metric refers to the measure, how it will be calculated, who will be carrying out the calculation and from where will be obtained (Gunasekaran & Kobu, 2007). For the last few decades, researchers have identified a number of performance metrics to evaluate lean SC performance. According to Arif-Uz-Zaman and Nazmul Ahsan (2014), lean SC had four major metrics categorise: cost, time, quality and flexibility. By making the most of these metrics, it can not only predict the overall SC performance under lean thinking, but also categorize the existing performance and optimise them accordingly.

3. Research method

3.1 FsQCA

FsQCA is fundamentally an analysis of set relationships. In fsQCA, variables are transformed into sets and what combination of casual sets constituting a subset of the outcome set are analysed. There are some advantages of fsQCA in comparison with traditional analysis method: (1) asymmetry which means the presence and the absence of the outcome may require different explanations; (2) equifinality meaning that different paths can lead to the same outcome; (3) casual complexity focuses not on the estimation of independent net effects but on the estimation of combinatorial effects (Elliott, 2013).

According to the user's guide to fsQCA (Ragin, 2008), three solutions exist for each analysis. A complex solution (without considering logical remainders) makes no simplifying assumptions. The parsimonious solution (considering all logical remainder) should be only used if the assumptions are fully justified. Finally, the intermediate solution (considering only plausible logical remainders) integrates only simplifying assumptions of easy cases (Rihoux & Ragin, 2009). Thus, the complex solution is the most appropriate, especially when the number of casual conditions is not large (Elliott, 2013; Ragin & Sonnett, 2005).

In fsQCA, the strength and importance of the relationship between the conditions and outcome are measured by two metric, consistency and coverage, which provide the parameters for measurement. Consistency represents the extent to which a causal combination leads to an outcome. Consistency ranges from 0 to 1. A consistency threshold is usually equal to 0.8 or more, and with high consistency scores indicate pathways that always lead to the given outcome condition (Elliott, 2013). Apart from consistency measures, coverage represents how many cases with the outcome are represented by a particular casual condition, in other words, coverage reflects how much of the outcome is explained by each solution pathway and the solution as a whole (Ragin, 2008). It is suggested that the solution is informative when consistency is above 0.74 and all coverage is between 0.25 and 0.90 (Woodside, 2013; Woodside and Zhang, 2013).

This study employs the qualitative comparative analysis technique using fuzzy sets to examine the causal relationship between antecedents (i.e., knowledge network types, knowledge mobilisation approaches and lean performance) and related to each specific metric. FsQCA helps tease out the complementarities and substitutions in different configurations of factors and allows a more nuanced analysis than conventional quantitative, correlational techniques (Crilly, Zollo & Hansen, 2012; Fiss, 2011). However, fsQCA carries some limitations. First, it does not allow the analysis of many variables because in case of

obtaining a unique model, interpreting that model would be very difficult. Second, fsQCA comes up with the empirical relevance and set theoretical importance of complex combinatorial paths to the outcome but cannot conclude on the unique contribution of each individual simple condition (Skarmeas, Leonidou & Saridakis, 2014; Fiss, 2011).

3.2 Sample

The Bureau van Dijk database provided a list of organizations for the survey. The managers in logistics and supply chain department of agri-food industry in the UK were selected. The Bureau van Dijk quickly identified a sample frame of 1558 organizations. A cover letter and questionnaire were sent to managers from corporate email addresses inviting them to participate in an online survey. 32 cases were used in this study. The questionnaire was pilot tested on four academic researchers and two of agri-food industry managers.

3.3 Statistics

In the present study, the outcome conditions are cost, time, quality and flexibility. Questionnaire survey is used for data collection. All items are rated on a five-point Likert scale anchored on “strongly disagree=1” and “strongly agree=5”. To match fuzzy set calibration with the five-point Likert scales used in this study, the original values of 5.0, 1.0 and 3.0 are set to correspond to the full membership, full non-membership and crossover anchors.

Table 1 shows the summary statistics for the variables, including the means, standard deviations and Cronbach’s alpha. The results indicate the dimensionality and reliability of all research constructs are quite reliable and accepted.

Table 1 Summary data for variables

Variable	Mean	Std. Dev.	Minimum	Maximum	N Cases	Missing	Cronbach’s α
fs_cost	0.598	0.328	0.05	0.95	32	0	0.923
fs_time	0.648	0.324	0.05	0.95	32	0	0.926
fs_qual	0.685	0.330	0.05	0.95	32	0	0.932
fs_flex	0.624	0.299	0.05	0.95	32	0	0.930
fs_info	0.664	0.316	0.05	0.95	32	0	0.930
fs_qa	0.680	0.292	0.05	0.95	32	0	0.927
fs_stra	0.582	0.347	0.05	0.95	32	0	0.928
fs_onl	0.590	0.290	0.05	0.95	32	0	0.927
fs_syn	0.574	0.320	0.05	0.95	32	0	0.929
fs_sem	0.590	0.350	0.05	0.95	32	0	0.922
fs_pra	0.602	0.350	0.05	0.95	32	0	0.927
fs_int	0.640	0.264	0.05	0.95	32	0	0.928

4. Results

The fsQCA method is implemented using fsQCA 2.5 software (Ragin, Drass & Davey, 2009). Table 2 illustrates the complex solutions and causal recipes of sufficient combinations, which lead to high membership in each of four outcome conditions. The table presents the complex solution because contrary to the parsimonious and intermediate solution, this type of solution makes no simplifying assumptions (Ragin, 2000). All four models are informative with consistency values higher than 0.74 and coverage values ranging between 0.25 and 0.90, following previous literature suggestions (i.e., Woodside, 2013).

Table 2 Complex solutions for the outcome conditions

Complex Solution	Raw coverage	Unique coverage	Consistency
Cost			
fs_info*fs_qa*fs_onl	0.771683	0.771683	0.891370
solution coverage: 0.771683; solution consistency: 0.891370			
frequency cutoff: 1.000000; consistency cutoff: 0.853659			
~fs_syn*fs_sem*~fs_pra*fs_int	0.225705	0.053814	0.905660
fs_syn*fs_sem*fs_pra*fs_int	0.717869	0.545977	0.959497
solution coverage: 0.771683; solution consistency: 0.942565			
frequency cutoff: 1.000000; consistency cutoff: 0.905660			
Time			
fs_info*fs_qa*~fs_stra	0.316779	0.052555	0.886640
fs_info*fs_qa*fs_onl	0.755545	0.491321	0.945685
~fs_info*~fs_qa*~fs_stra*fs_onl	0.211186	0.046287	0.860511
solution coverage: 0.854388; solution consistency: 0.901781			
frequency cutoff: 1.000000; consistency cutoff: 0.860511			
~fs_syn*fs_sem*~fs_pra*fs_int	0.195757	0.037126	0.851153
fs_syn*fs_sem*fs_pra*fs_int	0.662488	0.503858	0.959497
solution coverage: 0.699615; solution consistency: 0.925973			
frequency cutoff: 1.000000; consistency cutoff: 0.851153			
Quality			
~fs_info*~fs_qa*~fs_stra	0.287996	0.125970	0.817357
fs_info*fs_qa*fs_onl	0.700593	0.538567	0.926373

solution coverage: 0.826563; solution consistency: 0.878700			
frequency cutoff: 1.000000; consistency cutoff: 0.838757			
~fs_syn*fs_sem*~fs_pra*fs_int	0.197170	0.047010	0.905660
fs_syn*fs_sem*fs_pra*fs_int	0.635783	0.485623	0.972765
solution coverage: 0.682793; solution consistency: 0.954691			
frequency cutoff: 1.000000; consistency cutoff: 0.905660			
Flexibility			
~fs_info*~fs_qa*~fs_stra	0.309464	0.131697	0.800518
fs_info*fs_qa*fs_onl	0.784677	0.606910	0.945685
solution coverage: 0.916375; solution consistency: 0.887919			
frequency cutoff: 1.000000; consistency cutoff: 0.819527			
~fs_syn*fs_sem*~fs_pra*fs_int	0.206810	0.035553	0.865828
fs_syn*fs_sem*fs_pra*fs_int	0.688032	0.516775	0.959497
solution coverage: 0.723586; solution consistency: 0.922144			
frequency cutoff: 1.000000; consistency cutoff: 0.865828			

4.1 Relationship between knowledge networks and lean performance

Table 2 shows the derived solution for the antecedent conditions that lead to high membership scores for cost indicates one pathway. This pathway indicates that high informal networks, Q&A networks and online strategic network results in high cost metric (consistency=0.89; coverage=0.77). Thus, these three simple antecedent conditions are necessary and their combination is sufficient for high cost metric.

The solution examining time metric suggests three pathways. The first indicates that high informal networks and Q&A networks, with low strategic networks lead to high membership scores for time. This pathway is fairly consistent (consistency=0.86) and explains a satisfactory amount of cases with high cost metric (coverage=0.31). The second pathway indicates that high informal networks and Q&A networks with low online strategic networks also lead to high cost metric (consistency=0.94; coverage=0.75). Finally, the third pathway indicates that low informal networks, Q&A networks and strategic networks with high online strategic networks results in high time metric.

The pattern of results suggests some interesting conclusions. The high informal networks, Q&A networks, and online strategic networks are in two out of three recipes indicates that these conditions facilitate time metric, whereas low strategic networks may also contribute toward the same direction, however, they are not a necessary condition as they appear in two out of three of causal recipes.

The solution examining quality and flexibility metrics indicate two configurations. The first one suggests that low informal networks, Q&A networks and strategic networks can lead to high quality and flexibility metrics. Alternatively, high informal networks and Q&A networks and online strategic networks can also lead to the same outcomes.

4.2 Relationship between knowledge mobilisation and lean performance

Table 2 also illustrates the recipes that associate with high membership scores in the outcome conditions on knowledge mobilisation. Two pathways lead to high levels of lean performance. The first one indicates that low syntactic and pragmatic approach; with high semantic and integrative approach relate to high membership scores for lean performance, no matter regarding the cost, time, quality and flexibility metrics. The second pathway indicates that high presence of all the four knowledge mobilisation approaches may also result in high lean performance. This pathway is much more consistent than the previous one (consistency=0.96; 0.96; 0.97; 0.96) and explains a satisfactory amount of case with high lean performance (coverage=0.72; 0.63; 0.63; 0.69). As a whole, the solution has a satisfactory consistency and an acceptable coverage.

The solution suggests that there are two necessary (but insufficient) simple antecedent conditions for high lean performance, namely high semantic approach and integrative approach because all these two simple conditions appear in both causal recipes. On the other hand, the syntactic approach and pragmatic approach can be either present or absent depending on the combination of additional antecedent conditions that occur in the given causal recipe. For example, if syntactic approach is low, the pragmatic approach has to be low as well, while if syntactic approach is high, the pragmatic approach has to be high too.

5. Discussion and conclusions

The link between knowledge management and supply chain management is concerned with the use of phase of “knowledge supply networks” and “knowledge supply chains” (Marra & Edwards, 2012). Both phrases point out the important role of knowledge flows among actors of the supply chain network. However, there has been a lack of studies measuring the knowledge network models and mobilisation strategies on the lean SC performance. Therefore, this study contributes to the understanding of knowledge network/mobilisation by examining necessary and sufficient antecedent conditions to the successful lean SC performance outcome. This study emphasizes on the impact of knowledge network on lean performance and the impact of knowledge mobilisation on lean performance, respectively. The results show that no individual antecedent is enough (necessary) to generate high lean performance. Furthermore, the analysis of sufficient conditions reveals that the different combinations of them can lead to high lean performance. Overall, the effect of knowledge flow and sharing on lean SC performance is a systematic and long term process. Organizations with good knowledge communication channels and mobilisation strategies also need new knowledge and technology to accelerate the knowledge flow process.

From a managerial perspective, the findings produce several implications. First, lean performance seems to emerge in the presence of informal networks and Q&A network using semantic approach which translates specific knowledge to establish common meanings. Thus, organizations should consider concentrating on their grass-roots employees, closely monitoring their perceptions about knowledge flow and paying attention to their individual opinions on how to enhance SCM in order to achieve lean performance. Second,

organizations should recognize the important role of expert knowledge professionals who can bridge the gaps between experience sharing individuals and the organization, even the SC partners. Furthermore, more interactions such as intensive meetings also can produce systematic knowledge networks.

The study has limitations that present opportunities for future research. Firstly, different industries may prefer a specific knowledge network model and knowledge mobilisation strategy in the worldwide marketplace. In this regards, future research should investigate and compare these antecedent outcome relationships for different industries. In addition, this study draws heavily upon the literature review by Jashapara (2011) in terms of knowledge mobulisation approaches, future research should identify other antecedents from wider sources.

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