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## **A knowledge network and mobilisation framework for lean supply chain decisions in agri-food industry**

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### **Abstract**

Making the right decisions for food supply chain is extremely important towards achieving sustainability in agricultural businesses. This paper is concerned with knowledge sharing to support food supply chain decisions to achieve lean performance (i.e. to reduce/eliminate non-value-adding activities, or “waste” in lean term). The focus of the paper is on defining new knowledge networks and mobilisation approaches to address the network and community nature of current supply chains. Based on critical analysis of the state-of-the-art in the topic area, a knowledge network and mobilisation framework for lean supply chain management has been developed. The framework has then been evaluated using a case study from the food supply chain. Analytic Hierarchy Process (AHP) has been used to incorporate expert’s view on the defined knowledge networks and mobilisation approaches with respect to their contribution to achieving various lean performance objectives. The results from the work have a number of implications for current knowledge management and supply chain management in theory and in practice.

**Keywords:** lean performance, knowledge network, knowledge mobilisation, food supply chain

### **1. Introduction**

Sustainability of agriculture has been recognised as an important issue in recent years and lean has been regarded as an effective approach towards achieving the sustainability in food supply chains. Lean principles, concepts, tools and techniques have been developed and applied widely in the manufacturing industry due to the original contribution and tremendous influence from Toyota Production Systems (Slack, Brandon-Jones and Johnston, 2013). Applying lean thinking in food supply chains is however an underdeveloped topic because of a number of challenges including the lack of understanding of the nature of “waste” (i.e. any activities not adding value defined by lean theory) and lack of mature means of eliminating/reducing waste in food supply chains (Folinas et al, 2013). Subsequently, there is little report on best practices or lessons learnt on the topic of assessing the lean performance in food supply chains.

Knowledge management is a well-developed area which has been widely practised in supply chain context (Asgari et al, 2016). Various knowledge management approaches, models and systems have been developed including knowledge

creation, knowledge sharing, knowledge retention and application in both downstream and upstream supply chains (Shih et al, 2012; Clemons and Slotnick, 2016). With a closer look, the supply chain decisions that have used knowledge management theories cover many aspects such as ordering, procurement, distribution, supply chain configuration, location decisions, investment and strategy. Comparatively, the knowledge support for supply chain to achieve lean performance is scarce (Liu et al, 2012).

This paper is concerned with knowledge flow and sharing across stakeholders in supply chains and focused on knowledge networks and mobilisation in current digital environment and knowledge economy. An innovative knowledge network and mobilisation framework for lean knowledge supply chain decisions (Lean-KMob framework) has been developed. Three main constructs defined in the Lean-KMob framework include lean performance with specific measures, knowledge network types, and knowledge mobilisation approaches. The Lean-KMob framework is evaluated using empirical data from food supply chains. Key contributions of the work include the definition of key constructs and variables as well as the relationships among them, which can provide important implications for knowledge management and supply chain practice.

The paper is organised as follows: the following section reviews relevant work and identify research gaps in the literature. Section 3 presents the Lean-KMob framework in details. Evaluation of the framework is presented in Section 4 using a case study from food supply chains. Finally Section 5 discusses further issues and draws conclusions.

## **2. Related work**

This section reviews existing work in the topic area and looks at how the concept of supply chain (SC) and supply chain management (SCM) has evolved over time, including its integration with lean philosophy and lean SC decision making requirements. At the end of the literature review, the research gaps are identified in terms of knowledge management support for lean SCM decisions.

SC as a concept has been around since early 1980s. There have been a number of definitions available for supply chains. For example, SC was defined by the Institute of Logistics and Transport (CILT, 2016) as a sequence of activities in moving physical products or services from a point of origin to a point of consumption, including procurement, manufacture, distribution and waste disposal (Crandall, Crandall and Chen, 2010). The APICS (American Production and Inventory Control Society) Dictionary defines a SC as “global network used to deliver products and services from raw materials to end customers through an engineered flow of information, physical distribution and cash” (Blackstone, 2008). Some important observations can be made on the SC concept. Firstly, compared with the CILT definition, APICS definition has highlighted an important feature of a SC, that is, the flow of information, goods and funds which are essential for the integration of various

activities along the SC (Yuen and Thai, 2016). Another important evolution for SC is that SC were traditionally associated with the supply side (i.e. the upstream part of the SC), however in recent years, the demand side (closer to customers) has received more and more attention. Subsequently, some have used the term value chain in order to emphasize the importance of satisfying customers (Luzi, Marilungo and Germani, 2015). Currently, SC is the commonly acceptable term used for both supply and demand sides of the entire chain. SC and value chain are often used interchangeably without causing any problems for scholars and practitioners in the area.

SCM is the term that has been used to describe the functions of managing SC activities. One of the most widely accepted definitions is from the Council of Supply Chain Management Professionals (CSCMP, 2016): “SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers and customers. In essence, SCM integrates supply and demand management within and across companies”. SCM has received enormous attention from researchers since its beginning with extraordinary achievements over time. A number of review papers have been available which present SCM key issues, challenges, advances and research directions from different perspectives (Wang et al, 2015; Asgari et al, 2016; Borodin et al, 2016; Habib, Lee and Memon, 2016; Zimmermann, Ferreira and Moreira, 2016).

Lean originated from the automotive industry known as the Japanese Toyota Production Systems over half a century ago (from 1950s) with a focus on lean manufacturing (Gupta and Jain, 2013; Bhamu and Sangwan, 2014). Over the time, lean has advanced considerably into a multi-faceted concept. It is now commonly viewed as three things: a philosophy, a method of planning and control, and a set of improvement tools (Slack, Brandon-Jones and Johnston, 2013). Its core elements were comprehensively discussed for the first time in the famous book “The Machine That Changed the World” (Womack, Jones and Roos, 1991; Samuel, Found and Willaims, 2015). The book opened a window for researchers and practitioners into a new way of organizing the production of goods that departed greatly from the traditional American method of mass production such as the Ford assembly lines. Since then, many companies have adopted the philosophy and principles of lean manufacturing in their operations in order to continuously reduce cost through the elimination of all forms of waste (defined as non-value-adding activities in lean) (Vamsi, Jasti and Kodadi, 2014). However, the application of lean to SCM is much more recent - around 1980s, when manufacturing companies experienced a paradigm shift from a world consisting of companies competing against each other to that of supply chains competing against supply chains in order to meet the ever-more stringent demands of customers (Li and Found, 2016). Hence, the integration

of lean philosophy and practices into supply chain management (SCM) resulted in the emergence of the new concept of lean SCM in the 1990s (Liu et al, 2013).

In the context of SCM, lean concept has evolved to include richer meanings with a new term, lean synchronisation, in response to the need of addressing the flow of items (materials, information, funds and customers) throughout supply chains (Waurzyniak, 2012; Qrunfleh and Tarafdar, 2013). Evidence shows that in both production and service operations, as little as 5 percent of total throughput time is spent directly adding value, which means that 95 percent of its time, an operation is adding cost instead of value (Slack, Brandon-Jones and Johnston, 2013). There is no doubt that eliminating the 95 percent of non-value-adding activities (i.e., waste) from the supply chains will considerably improve the business efficiency and performance. Despite its great importance, research in lean SCM is relatively limited. A recent review reveals that even though many researchers have proposed novel frameworks, there has been a lack of participation of practitioners and to some extent consultants in the field of lean SCM framework development (Ma, Wang and Xu, 2011; Jasti and Kodali, 2015). It was also found that a huge number of incoherent elements were used to propose the lean SCM frameworks (Waurzyniak, 2012). Furthermore, there has been no consensus on what specific measures should be considered for lean SC performance assessment.

Over the last two-three decades knowledge management as a discipline has significantly advanced in parallel with SCM. In early 1990s, “knowledge worker” was used to distinguish from “manual worker” to emphasize that the creation of ideas and knowledge could add value to the firm (Druker, 1992). By middle of 2000s knowledge workers accounted for 42 percent of all employment in the UK (Brinkley, 2006). Subsequently, the concept of knowledge economy has emerged to confirm that an economy is driven by knowledge intangibles rather than physical capital, natural resources or low-skilled labour. So far, literature has reported on conventional knowledge management approaches for SCM from all perspectives, including both implicit and explicit knowledge (Schoenherr, Griffith and Chandra, 2014), all stages of knowledge lifecycle (from creation through sharing and transfer to use) (Samuel et al, 2011) and application of knowledge management theories to SCM in various industries (Al-Karaghoulis et al, 2013; Kanat and Atilgan, 2014). A number of literature reviews on knowledge management for SCM are already available providing a more comprehensive picture of the research advances (Marra, Ho and Edwards, 2012; Outahar, Nfaoui and EL Beqqali, 2013). However, existing research mainly address the KM issues from stand-alone point of view, that is, with a focus on organisational boundaries. There are still huge barriers for knowledge flow beyond the organisational boundaries because of the lack of mature and reliable knowledge communication channels and mobilisation strategies, even though the importance of knowledge networking and mobilisation requirements have been recognised (Liu et al, 2014). This paper aims to fill the research gap in the literature

in terms of knowledge flow and networks across organisation boundaries in order to mobilise knowledge throughout SC.

### 3. The Lean-KMob conceptual framework

This section discusses the conceptual framework developed for the knowledge mobilisation to achieve lean performance in supply chains (Lean-KMob framework). As shown in Figure 1, the framework is illustrated in the shape of a tower with five distinctive but related levels. Towards the bottom end of the tower, it emphasizes more on the knowledge sharing aspect of a supply chain. Towards the top end of the pyramid, the focus shifts more to achieving business performance, that is, lean objectives in this case.

On the foundation level (Level 1) is the commonly accepted SECI (Socialisation, Externalisation, Combination and Internalisation) model for **knowledge conversion**. SECI provides a classic knowledge conversion model which includes four different typical processes: socialisation, externalisation, combination and internalisation (Nonaka & Takeuchi 1995). *Socialisation* involves sharing tacit knowledge between individuals within an organisation but also in a supply chain context. *Externalisation* involves the articulation of tacit into explicit knowledge. *Combination* involves conversion of explicit knowledge into more complex explicit forms. Finally, *internalisation* is more on converting explicit into tacit knowledge. The SECI model establishes the fundamentals for knowledge sharing because knowledge flowing through a supply chain is either tacit or explicit. Without proper understanding of the conversion between the two types of knowledge, it is unimaginable to create a solid knowledge mobilisation framework. Hence, the SECI model has been adopted as the foundation of the Lean-KMob framework.

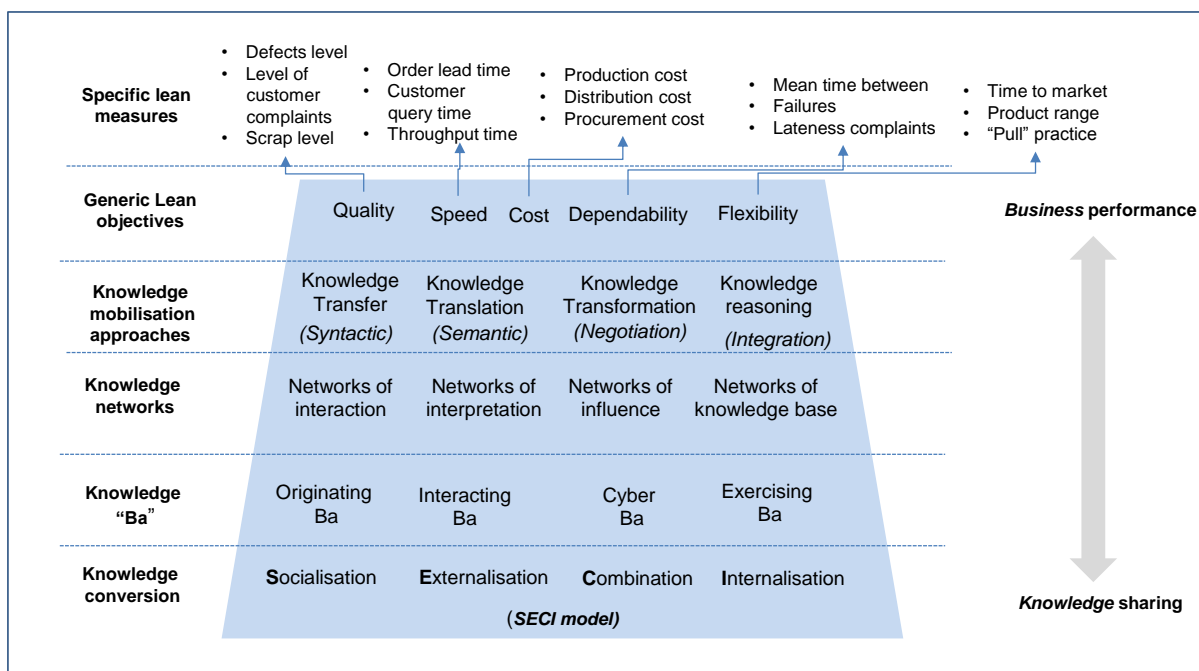


Figure 1 The Lean-KMob framework

While the conversion between tacit and explicit knowledge is understood through SECI model, it is important to define appropriate environment where knowledge conversion can take place. In knowledge management context, this environment is termed as knowledge space. **Knowledge “Ba”** theory sheds light on this (Nonaka and Konno, 1998). “Ba” is a Japanese word meaning “space”. Corresponding to the four knowledge conversion processes from the SECI model, the Knowledge “Ba” theory defined four knowledge spaces, namely, Originating Ba, Interacting Ba, Cyber Ba and Exercising Ba. *Originating Ba* is the knowledge space for Socialisation, where people can share tacit knowledge, for example in the form of experience and mental models. Externalisation (tacit into explicit knowledge) normally occurs through dialogues and the use of figurative language and narratives. The space required to facilitate this knowledge conversion is *Interacting Ba*. *Cyber Ba* promotes knowledge Combination by encouraging the documentation of knowledge and the use of knowledge bases and groupware tools. Finally, Internalisation usually occurs through leaning-by-doing and training. The space that encourages such knowledge conversion is *Exercising Ba*, characterised by reflection through learning, training and mentoring.

While Levels 1 and 2 are concerned with knowledge sharing in general, that is, the knowledge conversion and knowledge Ba theories can be used for knowledge sharing between individuals, among groups, within an organisation and extending beyond the organisation boundary, Level 3 and Level 4 of the Lean-KMob framework are focused on the knowledge flowing and sharing in supply chain context, specifically Level 3 on knowledge networks and Level 4 on knowledge mobilisation approaches. **Knowledge networks** (knowledge chains) have been suggested as mechanisms that help supply chain partners share knowledge beyond organisation boundaries and enhance communications between producers and users of supply chain wide knowledge, such as customer and market knowledge, supply network configuration knowledge, and global capacity knowledge (Capo-Vicedo, Mula and Capo, 2011; Liu et al, 2014). Four types of knowledge networks can be identified in supply chains: knowledge networks of interaction, knowledge networks of interpretation, knowledge networks of influence, and networks of knowledge bases (Alkuraiji et al, 2014). Defining knowledge networks is crucial not only for knowledge sharing among SC partner, but also enabling knowledge traceability when knowledge flows among different stakeholders including end customers and material providers (Gianni, Gotzamani and Linden, 2016). Only when knowledge networks have been defined, effective communication channels can be established. Later, Alkuraiji et al (2015) further developed structured knowledge networks and applied them to IT project supply chains.

If knowledge networks can be seen as the “hardware” for knowledge sharing, **knowledge mobilisation** approaches would be the “software” that provides the capability of efficient and effective knowledge sharing throughout supply chains. Knowledge mobilisation approaches can be defined from various perspectives 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. The most basic approach would be syntactic knowledge transfer. This *syntactic approach* assumes a mechanical notion of communication of knowledge, most suitable for explicit knowledge transfer. Where this perspective becomes unstuck is the introduction of new knowledge and new conditions which lie outside the boundaries of the current syntax (language) (Jashapara, 2011). As novelty increases, some meanings can become ambiguous and interpretive differences becomes wider especially across supply chain partners with different world views. In such situations, there is a need to develop a common meaning to address interpretive differences across semantic boundaries. The key role of such a *semantic approach* is knowledge translation. Literature has indicated the importance of developing shared meanings for supply chain partners to participate in knowledge networks (Yue et al, 2007). When novelty increases even further, it is important to recognise that knowledge is embedded, localised and invested in practice. A *pragmatic approach* to crossing knowledge boundary is to transform existing knowledge in order to resolve different interests of supply chain partners. This approach recognises the need of negotiation as part of the knowledge mobilisation process (Hara and Sanfilippo, 2016). The perspective with the highest level of boundary-spanning capability is *knowledge reasoning* (Pan et al, 2014). Powerful reasoning mechanisms can not only resolve different SC partner's interests horizontally as well as vertically integrate past knowledge into current decision making practice, but also integrate the whole supply chain to reflect on the decisions, learn from the past, evaluate itself and adapt to changes to become a true "learning supply chain" (Qiu et al, 2007).

The main purpose to investigate new knowledge mobilisation approaches is to help achieve **lean performance objectives** in SC. The five generic performance objectives shown on Level 5 have been identified in SCM literature and widely adopted in many SCM practices (Slack, Brandon-Jones and Johnston, 2013). In relation to lean SC, specific performance measures have been defined for each of the five performance objectives, which are illustrated as an extended level above Level 5. These specific lean measures can be used to assess SCM performance with respect to the reduction and elimination of all types of "waste" (i.e. non-value adding activities) (Liu et al, 2014).

To sum up, the five-level Lean-KMob framework not only integrates knowledge sharing with business performance, but also highlights the knowledge networks and mobilisation approaches dedicated to SC decisions. The framework is built upon the classic and widely adopted knowledge management theories, in particular the famous SECI model and knowledge "Ba". Therefore, the Lean-KMob framework has a solid theoretical foundation, but is customised to SC context with a firm focus on achieving lean performance objectives.



#### **4. Evaluating the Lean-KMob framework in food supply chains**

This section discusses the evaluation of the Lean-KMob framework developed from this research using a case study from agri-food supply chains. Agriculture has been recognised as one of the most important sectors facing challenges from waste elimination and sustainability. From the SCM point of view, food supply chain is perfect for the case study for evaluating the Lean-KMob framework because of its key characteristics (Folinas, 2013; Afonso and Cabrita, 2015): (1) food supply chain is relatively short but has high uncertainty, i.e. customers and suppliers can change relatively quickly compared with other SC such as electronics, car and aero-space supply chains. (2) Food products have relatively short shelf-life, hence the production and delivery need to be more flexible, for example, to adopt a pull system for the SCM to avoid over-production and reduce inventory level (these are all different types of waste in lean management). (3) Food safety is extremely important to customers. Products with quality issues often have very severe consequences including loss of people's lives. Quality management and assurance have to be on top of the management priority list throughout the supply chain. Best practices and knowledge sharing are in the centre of food supply chain management. (4) Food is a necessity to all people rather than a luxury. Customers are sensitive to the price, subsequently all activities involved in the supply chain (including farming, food processing, distribution and retailing) have to be co-ordinated and integrated to minimise the total cost, in order to offer a reasonable price to customers. Based on the above, any lean decisions for food supply chains to realise the performance objectives have to consider multiple criteria. Hence this research used a widely accepted multi-criteria decision analysis method, Analytic Hierarchy Process (AHP), to incorporate expert's preferences and opinion, facilitated by a AHP analysis tool, Expert Choice<sup>®</sup>.

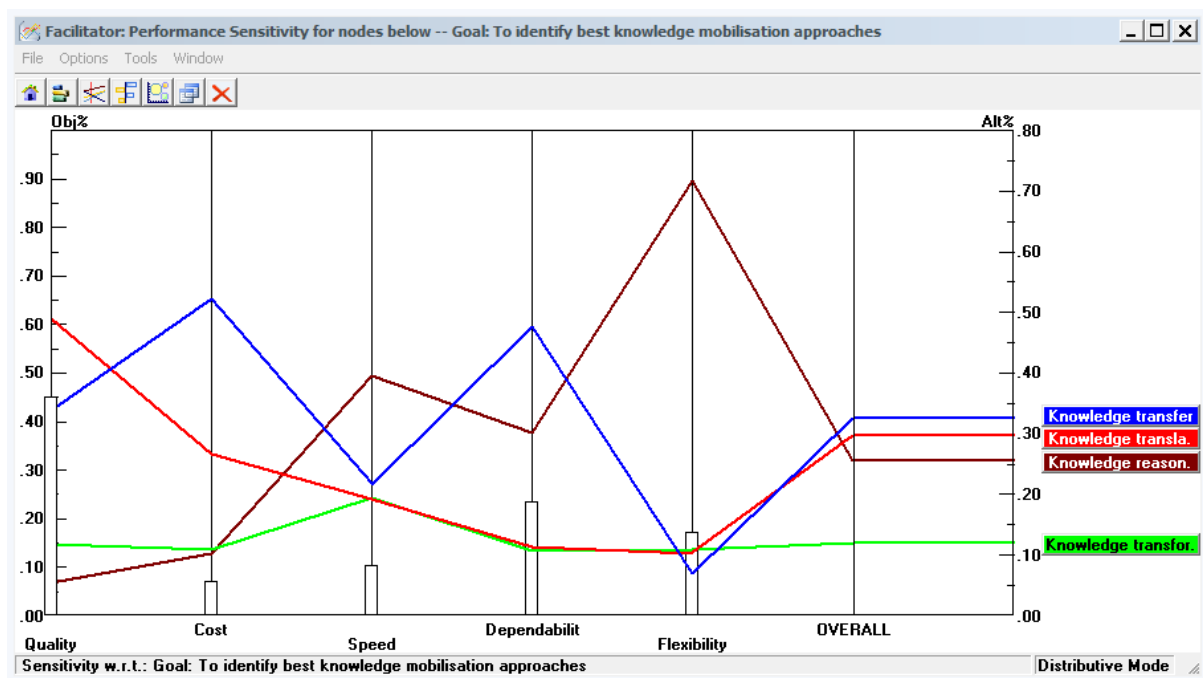
The evaluation process consists of two key tasks:

- Task 1: to rank and prioritise the lean performance objectives in food supply chains.
- Task 2: to rank and prioritise the knowledge mobilisation approaches and knowledge networks with respect to their contribution to lean performance objectives.

AHP is a widely used method for multi-criteria decision analysis (Jayawickrama, 2015; Arrais-Castro et al, 2015). One of the benefits of using AHP in this research is that decision maker's preferences can be incorporated during the pairwise comparisons conducted for the identified lean performance objectives (quality, speed, cost, dependability and flexibility), for the knowledge mobilisation approaches (knowledge transfer, knowledge translation, knowledge transformation and knowledge integration), and for the knowledge networks (i.e. networks of interaction, networks of interpretation, networks of influence, and networks of knowledge bases). With the support from the Expert Choice, the global priority of each of the lean

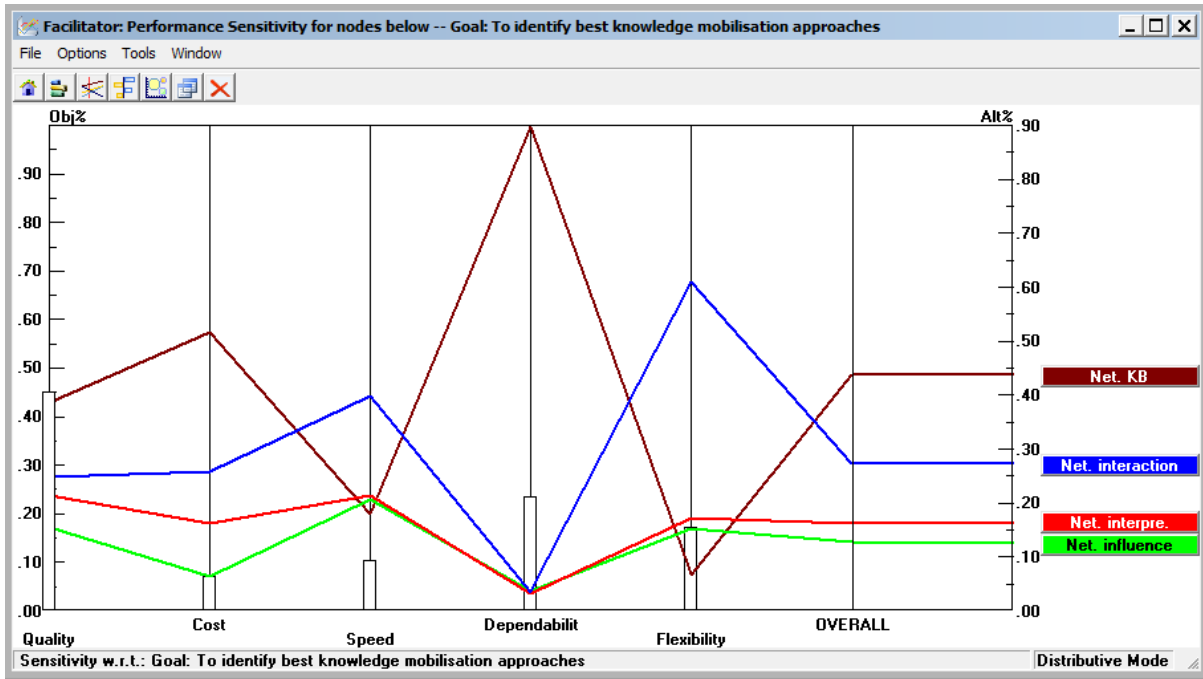
performance objectives, mobilisation approaches and networks can be accurately calculated and visually represented.

Figure 2 shows the results of the global priority of the five lean performance objectives based on experts' opinion from food supply chains. The importance of each objective is represented by the height of the bar. As can be seen from the Figure, experts gave "Quality" the highest importance (0.45), followed by "Dependability", "Flexibility" and "Speed", with "Cost" the lowest priority (less than 0.1). Please note that the AHP scores represent the "relative" importance of each objective and the sum of all scores should be equal to 1. Figure 2 also illustrates the experts' opinion on how each of knowledge mobilisation approaches' contribution to relevant lean objectives, represented by the graphs in different colours. For example, the "Knowledge translation" approach (the red graph) makes the most contribution while "Knowledge reasoning" (brown graph) makes least contribution to achieving the "Quality" objective, however, "Knowledge reasoning" becomes the most important approach when contributing to "Flexibility" objective. In terms of their overall contribution to lean performance, "Knowledge transfer" (blue graph) is ranked the most important, and "Knowledge transformation" (in green colour) ranked the least important.



**Figure 2 Knowledge mobilisation approaches ranked against lean performance objectives**

Similarly, the experts' opinion on how different knowledge networks contribute differently to realise the lean performance objectives has also been collected and analysed. Figure 3 summaries the results.



**Figure 3 Knowledge networks ranked against lean performance objectives**

Based on the results, “Networks of knowledge base” (shown in the brown graph) has received the highest score from experts – it has been ranked the most important network to contribute to three out of the five lean objectives: dependability, quality and cost. As a result, overall, “Networks of knowledge base” is the most important network, followed by “Networks of interaction” (in blue colour) and “Networks of interpretation” (in red), while “Networks of influence” (in green) was given the lowest overall score.

The above results are based on the opinion collected from food supply chain experts, in order to demonstrate how decision maker’s subjective preferences can be considered in the decision making process. It is by no means that the results can be generalised for other supply chain decision making situations at this stage. It is important that knowledge management considers specific industrial characteristics and experts’ background when making use of the results from this research.

## 5. Conclusions

Lean supply chain management has emerged as an important concept through the pioneer research in integrating lean philosophy with supply chain management. Knowledge sharing has been recognised as a key area to enable the lean supply chain performance objectives to be effectively realised in real industrial context. This paper proposed a knowledge network and mobilisation framework aiming to achieve lean SCM objectives. The Lean-KMob framework is evaluated through a case study from agri-food industry. The paper makes contributions to lean SCM in a number of aspects:

- (1) The five level Lean-KMob framework establishes connections between knowledge sharing and lean supply chain performance objectives;
- (2) The framework defines four knowledge mobilisation approaches (from syntactic, through semantic and negotiation, to intelligent reasoning) underpinned by four types of knowledge networks (networks of interaction, interpretation, influence and knowledge bases);
- (3) The case study in food supply chain indicates the relative importance of five lean performance objectives (quality, speed, cost, dependability and flexibility);
- (4) The case study in food supply chain reveals the most important knowledge mobilisation approaches and networks with respect to achieving different lean performance objectives.

The limitation of the work lies in the evaluation of the framework which has been undertaken using expert's subjective ranking. Future work will extend the study of the relationships between the knowledge network/ mobilisation elements and lean performance objectives using objective methods such as the fuzzy set qualitative comparative analysis (fsQCA). Further research will also evaluate the Lean-KMob framework in other supply chain contexts such as in the electronics industry.

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