Review on Knowledge Management as a Tool for Effective Traceability System in Halal Food Industry Supply Chain

Siti Zakiah Melatu Samsi[1]
e-mail: zakiah.melatu@mmu.edu.my

Othman Ibrahim[2]
e-mail: othmanibrahim@utm.my

Rahayu Tasnim[3]
e-mail: rahayu.tasnim@gmail.com

Author(s) Contact Details:
[1] *Multimedia University, Ayer Keroh, Melaka, Malaysia*
[2] *Universiti Teknologi Malaysia, Skudai, Johor, Malaysia*
[3] *Universiti Teknikal Malaysia, Melaka, Malaysia*

Abstract—The flourishing worldwide Halal food industry needs an excellent and reliable traceability system to ensure that consumers are persistently well protected from unconsciously consuming non-halal food which is against the Islamic law or the Shari'ah. There are various types of traceability systems being implemented by different food industries, not only in Malaysia but around the world. However, in perspective to the Malaysian Halal industry, there are countless cases discovered by the authorities and the consumers signifying for a better traceability system to be implemented by industry players, in particular the supply chain stakeholders. This paper aims to explore how knowledge management can be a commanding tool for an effective traceability system in our Halal food industry supply chain. The paper kicks off with an overview of the Halal concept followed by a discussion on traceability systems in the Halal food industry as well as the different traceability systems that have been implemented in other food industries globally. The Knowledge Management concept is then discussed and trailed with how it can be used as a tool in the traceability system. The final part of this paper proposes how the knowledge-based system can contribute as an effective traceability system in the Halal food supply chain.

Keywords – traceability; knowledge management; halal; food industry; supply chain

1. INTRODUCTION

The Halal food industry has become one of the key industries in Malaysia. Various initiatives have been taken by a multitude of government agencies including the Ministry of International Trade and Industry, the Department of Islamic Development Malaysia, the Ministry of Domestic Trade, the Cooperative and Consumerism Organisation and many other government-linked organizations to realize the national mission to become a Global Halal Hub as stated in the Ninth Malaysia Plan [1]. In line with all the initiatives taken by the relevant parties and stakeholders, the local Halal industry is aggravated with challenges particularly with its traceability system given that there are no specific standards or practices being introduced at the industry level. The manufacturers and food producers are duty-bound to rely on their own way of tracing and tracking information, needing to ensure the halal-ness of ingredients, processes and in handling of raw materials, half-processed / processed foods before all these reach to end consumers. As for the local consumers' perspective, reported complaints include the finding of non-Halal Deoxyribonucleic acid (DNA) in ingredients produced and sold in Halal certified premises that openly promotes and bring together both Halal and non-Halal provisions albeit its display of the Halal logo, the application of fake Halal logo in premises or product packaging and the use of self-produced Halal logos to maneuver consumers. To add, the easy access of non-verified and unreliable online information results in misconception and misinformation amongst the Malaysian Muslims, creating a wave of distrust and uncomfortable emotions and perceptions of the entire local Halal system. In light of this, consumers are still not rest assured that every single food product served on their plates is Halal. Meals may fall under the 'syubhah' category as stated in the Hadith reported by Bukhari, Muslim, Abu Daud, Ibn Majah and Darimi:

> *"What is Halal is clear. And what is Haram (not-Halal) is also clear. And in between those two is a dubious area in which many people do not know about. So whoever distanced himself from it, he has acquitted himself (from blame). And those who fall into it, he has fallen into a state of Haram."*

To ensure that a product is beyond doubt Halal, its ingredients, processing, handling, packaging, storage and distribution must accord to the Halal rules and regulations stated in the Islamic law. In short, the entire supply chain processes and activities must be certified as Halal compliant. To illustrate, if a food product consists of imported ingredients, every single ingredient need to be checked in terms of its Halal-ness, which inevitably involves investigations on its supply chain. The best terminology to illustrate this process is 'traceability'. Traceability in the Halal industry is defined as the ability to trace the Halal status of each product from farm to fork, or from its raw material to its finished product. This process involves all of the players in the supply chain in terms of their utmost commitment and comprehensible knowledge on the Halal concept.

Traceability is notably critical in the Halal supply chain. The study on traceability initially focuses on ensuring the food safety due to the increasing number of food health and safety issues such as e-coli and mad cow disease, to name a few, over the years. Researchers began studying on traceability systems used in information technology tools such as Radio Frequency Identification Detection (RFID) , [2] , [3] and [4] , Barcode [5] and [6], Electronic Data Interchange (EDI) [7] , [8] and [9], Geographic Information System (GIS) [9] and [10]. However, research on how knowledge management may contribute as a tool in the local traceability system has yet to be discussed albeit the vast literature on Knowledge Management applied in traceability solutions especially in the global food industry context. Most of the researches are applied in other countries and focuses on health and safety issues. As of today, no research has yet to apply knowledge management theories into the Halal supply chain, creating a Halal traceability system that may inevitably help our Halal based industry players. It is therefore the intention of this paper to propose the application of knowledge management into our Halal supply chain in order to model an effective and reliable traceability system.

2. OVERVIEW OF HALAL CONCEPT

The Halal food industry has been established initially to serve Muslim consumers worldwide. However, the wholesomeness concept of Halal that covers not only on Halal or religious requirements aspect but also cleanliness, health and safety makes Halal food products the choice of people regardless of race and religion. The literal definition of Halal is lawful or permissible [11]. The requirement of Halal is based on Islamic laws (the Shari'ah law) which is based on the Qur'an and the Sunnah. In Malaysia, the requirements of Halal food are stated clearly in the Malaysian Standard of Halal Food published by the Malaysian Department of Standards. Table 1 summarizes the general requirements of Halal food implemented in Malaysia [12]:

TABLE 1: General requirements of halal food implemented in Malaysia.
Source: Malaysian Standard of Halal Food, Malaysian Department of Standards.

No	Requirements
1	Does not contain any parts or products of animals that are non-halal to Muslims or products of animals which are not slaughtered according to Shari'ah law,
2	Does not contain any ingredients that are Najs according to Shari'ah law,
3	Is safe and not harmful
4	Is not prepared, processed or manufactured using equipment that is contaminated with things that are Najs (filth or unclean) according to Shari'ah law,
5	The food or its ingredients do not contain any human parts or its derivatives that are not permitted by Shari'ah law
6	During its preparation, processing, packaging, storage or transportation, the food is physically separated from any other food that does not meet the requirements stated in items 1., 2., 3., 4. or 5. or any other things that have been decreed as Najs (filth or unclean) by Shari'ah law.

The Halal food requirements presented in Table 1 above clearly indicate that Halal is not only fulfilled by observing the ingredients of the food but also the safety and cleanliness aspects which have to be strictly monitored throughout the stages of production i.e. production, processing, packaging, storage and transportation. It means that all the stages along the supply chain must be ensured as accomplishing all requirements according to the Halal standard. It is a comprehensive concept of protection for Muslims which covers not only religious requirements such as avoiding alcohol and pork but also safety, health and cleanliness characteristics of the product. This concept is known as the "Halalan Thoyyiban" (which means Halal and Good/Preferred) concept which shows the righteousness concept of Halal [13]. The Halal standard as being practiced in Malaysia is a comprehensive standard that covers everything needed in the Halal product production. However, for business purposes, a company may require to comply with additional requirements formed by other parties, for example, exporting countries, to get other certifications such as Hazard Analysis and Critical Control Point (HACCP) and Good Manufacturing Practices (GMP). The fulfillment of Halal plus all the additional requirements show that a food product produced by Halal manufacturers reaches certain quality levels or standards that could not be questioned by either Muslim or non-Muslim consumers.

3. TRACEABILITY IN THE HALAL FOOD INDUSTRY

Traceability and the food industry can never be separated. The break of the Salmonella virus, bird's flu and many other diseases that originate from the sources of food illustrates to manufacturers the vitality of traceability, in particular to the food industry [7]. Traceability promotes transparency along the supply chain which reduces the potential of product recalls as well as liability claims towards the manufacturers [3]. Traceability is also a communication and tracking mechanism to ensure information is accessible along the supply chain [14]. With regards to traceability, the Malaysian Halal food industry is still facing a multitude of challenges albeit the country racing really hard to position itself as a Global Halal Hub via its many initiatives implemented by government agencies. Through several enforcement programs conducted by the Malaysian authorities after the enactment of the Trade Description Act 2011, many food premises and manufacturers were caught as using unrecognized Halal certificates at their premises or on their products' packaging [15]. The traceability system being implemented in the food industry ranges from a basic manual documentation system which stores all the relevant information along the supply chain to a more complicated system using information technology software and tools. Table 2 summarizes the traceability adoption in different food industries and countries from the literatures and on the systems that are being used in implementing traceability.

TABLE 2: Food traceability system adoption in different countries

Country	Industry/ selected case study	System/ Technology	Description	Source
Portuguese	Pear	1. Integrated Protection Orchard Management 2. EurepGAP	Voluntary but farmers abide to legal requirements. More stringent system that require detail information registered & recorded in the system.	[16]
EU	Fourth range vegetable (clean, cut, mixed and packed vegetable products)	Computerized traceability system	Computer based system is developed for traceability information flow management.	[17]
US	Bulk grain	Electronic Data Interchange (EDI)	EDI allows electronic exchange between different partners or within organization which enables relevant information to be \exchanged electronically.	[7]
Norway	Fresh strawberry	• EDI • ERP	Using 13 digits product code that represent exact place, country of origin, product number & specific product features.	[8]
EU	Animal	IDEA project – to study the feasibility of electronic device for traceability.	Electronic Identification device on cattles, sheeps and goats. The device is known as transponders.	[18]
Netherlands	Beef	Identification & registration system (I&R) with unique life number and eartags containing the numbers.	A central database that keep calf/cow data and updated when the calf/cow leaves the farm.	[3]
Italy	Pig meat	RFID	RFID tags transmit data to a distributed database during all phases of the production process.	[19]
Malaysia	Halal	HTTS - Computerised Halal Traceability and Tracking System	Using RFID to track the raw materials from it sources until finished product.	[20]

As can be gleaned from the table, we may conclude that there are multiple ways traceability systems can be implemented in the food industry. Most importantly, however, are its tools or technologies that must be enabled and capable to track and trace the required information efficiently at any given production point. In doing so, the possibility of any unwanted events may well be avoided.

4. KNOWLEDGE MANAGEMENT

The saying "Knowledge is an important asset in an organization" has become increasingly popular ever since the emergence of the Knowledge Management concept few years back. Nonaka and Takeuchi [21] in their research found that the Japanese do not solely focus on explicit and structured knowledge but also on tacit knowledge which enables them to become highly innovative in achieving competitive advantage. Hao-yu et. al [22] defines Knowledge Management as the effort by organizations to assemble different types of knowledge from different parts of the organization which includes experience, technology, intelligence and ability, then ensuring that these knowledge would be easily accessed by people. Knowledge Management is also defined as an explicit and systematic management of important knowledge which involves the creation, organization, diffusion, the use and exploitation processes [23]. Knowledge can be divided into two categories, (1) Explicit Knowledge i.e. formal and systematic knowledge that can be viewed in many forms such as data, formulas and codified procedures or (2) Tacit Knowledge i.e. not visible, personal, difficult to be shared and is not easily expressed [24]. The process of knowledge creation involves knowledge conversion processes based on the SECI model (Socialization, Externalization, Combination and Internalization). The example of external parties that are involved in knowledge creation as stated in Takeuchi [25] are suppliers, customers, dealers, local communities, competitors, universities, the government and other relevant stakeholders. Figure 1 illustrates the process of knowledge creation as discussed by Nonaka and Takeuchi, 1995.
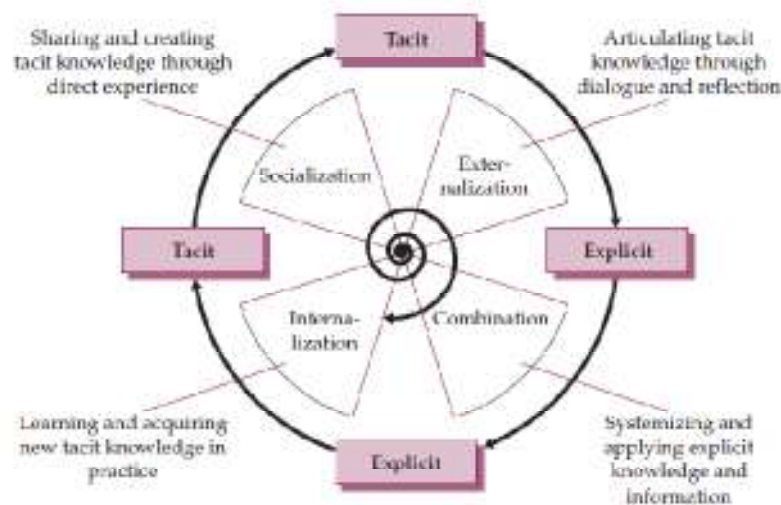

FIGURE 1: SECI model. Source: Nonaka and Takeuchi (1995)

Organizations can achieve core competencies through utilization of knowledge with its supply chain partners [26]. According to Hao-Yu et al [22] core competence can be defined as the collective knowledge of an organization which is the combination of different skills, capabilities, technology and management systems as well as values and norms. It is said that if all the players along the supply chain are willing to participate in the creation of knowledge and knowledge sharing activities, the organization will be able to achieve its competitive advantage.

A. Knowledge Management and Traceability System

An organization, a business firm, a manufacturing company or any institution can never survive standing alone. What more when it comes to business expansion and gaining the desired competitive advantage. These entities depend on each other to supply the needed raw materials, equipments, semi-processed products as well as to provide the relevant services for their day to day operations. In short, the interconnected web of reliance on one another is vital for survival particularly in the highly globalised business context that businesses are in today. This phenomenon describes the general environment of a supply chain in any business organization consisting of the organization itself, the suppliers, distributors, logistic operators, wholesalers, retailers and end consumers covering procurement, processing, storage, logistics and distribution systems of the organization [27]. To ensure accountability in the food market, knowledge in the food system must be created and managed so that consumers are constantly being rest assured on the righteousness of the Halal system.

Along the supply chain, knowledge may be illustrated as based on four different sources i.e. inside enterprise, outside enterprise, conformed knowledge and common sharing knowledge [28]. In their writings, Chunyan & Yali [28] describes how Knowledge Management in the supply chain is able to enhance competitive advantage through utilization of knowledge from the whole supply chain partners, rather than from a single enterprise. Knowledge Management in supply chain is also very helpful in decision making among supply chain professionals according to Zhang et. al [29] especially in procurement, supplier selection, outsourcing decision and production related decisions. The knowledge that is being shared from other supply chain players enables the organization to make the best/correct decisions. It is also discussed in their paper on how knowledge management promotes transparency between suppliers, key customers and partners, improving efficiency of the supply chain where real time information is shared. Smith [30] stresses that knowledge management along the supply chain allows manufacturers to be more competitive, innovative and support effective relationship with stakeholders. Gung Wu and Yu [31] on the other hand propose collaborative Knowledge Management among the supply chain partners will improve product quality through organizational coordination where capabilities can be accessed for higher quality knowledge.

It is easy to assume how food traceability would indeed involve a process of tracking relevant data inclusive of the product history and development and in the age that we are living in today, all this must be readily and easily accessed using information technology. For this reason, it is vital for supply chain members to comprehend the knowledge that they have and its importance to their business, as well as the knowledge that they are able to share [32]. To ensure traceability, real-time automated data and knowledge must be able to be traced to alert the important stakeholders on any relevant issues and on the development of the industry which can be realized through a knowledge-based system [33]. Table 3 depicts the type of knowledge along the supply chain which is of utmost importance to the food industry.

Supply chain partners must be able to share capabilities through experience sharing, methodological know-how, best practices systems and norms so that the common objectives can be achieved. In the context of a traceability system, the supposedly shared objective of all supply chain players is to produce a product that is able to be traced and tracked at all stages of supply chain. Precise knowledge of every supply chain partner such as the logistic providers, suppliers, manufacturers are also necessary for traceability. Information that is being exchanged and flows among the supply chain partners is crucial in ensuring that the traceability system developed is efficient and therefore, successful. Chen et. al [36] outlines the information required for an effective traceability system as follows:

a)   The operation process standardization from producing to selling.
b)   The total quality management processes from producing to selling, including the procedures and practices.
c)   The detailed records on each status and event in the entire supply chain.
d)   Third party certification information.

TABLE 3: Type of Knowledge in Supply Chain

DESCRIPTION	TYPE OF KNOWLEDGE	SOURCE
KM in supply chain helps in achieving core competencies that promote innovation and integrated capabilities between supply chain partners.	Experience, intelligence, staff knowledge and skills, tangible technological system, management system, values and norms.	[26]
Divided KM for 3 different tasks: • KM for design task of logistic processes • KM for Management Task • KM for execution tasks	• Methodological know-how, modern design concept & best practices. • Historic data for analysis & workflows information. • Logistics processes	[23]
Knowledge is divided into 2 types: • Quantitative knowledge (business data) • Qualitative knowledge (human data)	• Discovered from databases through data mining • Experience and judgment from decision making process	[32]
Knowledge in hierarchical model (5 layers) • Personal knowledge • Knowledge of department • Knowledge of firm • Knowledge of industry • Knowledge of supply chain	• Experience and problem solution about work and services • Collection of knowledge in the department context • Shared knowledge about manufacturing, management and services • Public knowledge about an industry • 1) Explicit knowledge (system, criterion and non-secrecy documents), 2) Tacit knowledge (culture, experience and intangible knowledge) and 3) Innovation knowledge.	[34]
Exploiting knowledge in organization improve competitive advantage of the firm.	Brands, reputation, customers and suppliers relationship.	[35]

B. Knowledge Management as an Effective Halal Food Traceability System: A Discussion.

At this point is it not difficult to see that the most significant element in food traceability is the transparency between all industry stakeholders especially the supply chain partners on knowledge so that shared objectives can be achieved. In the Halal food industry context, the knowledge required by stakeholders are the knowledge that is related to the Halal status of the product which includes most of the supply chain knowledge presented in the Table 3. Tacit knowledge such as experience, intelligence and the experience of the staff that handle the production process is also depicted in the Halal process. To illustrate, in the slaughtering process, the person in-charge of the process must be a Muslim. The staffs that handle production processes must be aware and has a certain level of understanding about Halal requirements so that all the processes are complied with the Halal requirements.

Knowledge on the Halal logistics is inevitably a very critical aspect in the Halal supply chain. Contamination with non-Halal substance must be avoided by Halal logistic providers where certain requirements must be fulfilled before companies can be appointed as logistic providers by Halal food companies. In this context, the Halal food companies should receive comprehensive knowledge about the logistic providers' processes, systems, standard operating procedures, track record as

well as its reputation which can be recognized through knowledge-based systems collaborating and evolving amongst supply chain partners.

Learning and exploring best practices and industry know-how is also important for the Halal supply chain stakeholders to improve their existing traceability systems. The willingness of supply chain partners or stakeholders to share their best practices in Halal related processes enable the industry to grow and achieve competitiveness in the market, therefore realizing the nation's mission to become a respected Global Halal Hub. By implementing the best methods of production which conforms and backed up by the traceability processes, the manufacturer or the firm would be able to gain consumers' trust and confidence. In short, businesses will innovatively achieve its desired competitive advantage, without sacrificing its ethics, nobility and righteousness.

Finally, both explicit and tacit knowledge about the industry need to be shared and disseminated among the industry stakeholders so that any relevant development can be utilized by the firm to improve their performance in achieving shared objectives. The performances of Halal firms highly depend on the levels of trust by consumers. And again, this level of trust may be elevated from time to time with an efficient halal traceability system.

5. CONCLUSION

An effective traceability system in our local Halal food industry supply chain needs to be developed and modeled being it a critical aspect for the industry to survive in the global halal food market and industry. Traceability enables industry stakeholders to trace and track important information at all stages of production and enables to reduce product re-call and the number of non-compliance cases discovered by the authorities resulting in a negative impact to the industry growth. However, the implementation of the knowledge based traceability system requires stakeholders' willingness to collaborate especially among the supply chain partners so that useful knowledge existing along the supply chain is readily and easily available for maximum utilization by all industry players. Since this paper is conceptual, further investigation must be done to study other important aspects in knowledge management implementation in the Halal food industry with regards to traceability such as the peoples' culture, the enablers and the required infra and info structure so that a knowledge-based traceability system framework can be developed for the industry.

REFERENCES

[1]   "Ninth Malaysia Plan 2006-2010.," Economic and Planning Unit, Malaysia.2006.

[2]   D. Folinas, *et al.*, "Traceability data management for food chains," *British Food Journal,* vol. 108, pp. 622-633, 2006.

[3]   M. P. M. Meuwissen, *et al.*, "Traceability and Certification in Meat Supply Chains," *Journal of Agribusiness,* vol. 21, pp. 167-181, 2003.

[4]   R.-S. Chen, *et al.*, "Using RFID Technology in Food Produce Traceability," *WSEAS Transactions on Information Science and Applications,* vol. 5, pp. 1551-1560, 2008.

[5]   R. G. Pettitt, "Traceability in the food animal industry and supermarket chains," *Rev. sci. tech. Off. int. Epiz,* vol. 20, pp. 584-597, 2001.

[6]   K. A.-M. Donnelly, *et al.*, "The importance of transformations for traceability – A case study of lamb and lamb products," *Meat Science,* vol. 83, pp. 68-73, 2009.

[7]   M. Thakur and C. R. Hurburgh, "Framework for implementing traceability system in the bulk grain supply chain," *Journal of Food Engineering,* vol. 95, pp. 617-626, 2009.

[8]   P. Engelseth, "Food product traceability and supply network integration," *Journal of Business & Industrial Marketing,* vol. 24, pp. 421–430, 2009.

[9]   M. Karkkainen, *et al.*, "Efficient tracking for short-term multi-company networks," *International Journal of Physical Distribution & Logistics Management,* vol. 34, pp. 545-564, 2004.

[10]   L. U. Opara, "Traceability in agriculture and food supply chain: a review of basic concepts, technological implications, and future prospects," *Food, Agriculture & Environment,* vol. 1, pp. 101-106, 2003.

[11]   (2011, 22 October 2011). *Halal Definition*. Available: http://www.malaysia.gov.my/EN/Relevant%20Topics/IndustryInMalaysia/Business/AgricultureAndAgroBasedIndustry/AgroHalalCertification/AgroHalalDefinition/Pages/AgroHalalDefinition.aspx

[12]   D. o. S. Malaysia, "Malaysia Standard," in *Halal Food - Production, Preparation, Handling and Storage - General Guidelines (Second Revision) MS 1500:2009*, ed. Malaysia: Department of Standards Malaysia, 2009.

[13]   Z. M. Janis. (July - August 2004) Malaysian Standard MS 1500 : 2004 Halal Food - Production, Preparation, Handling and Storage - General Guidelines (First Revision). *Standards and Quality News*.

[14]   S. Zailani*, et al.*, "Halal Traceability and Halal Tracking Systems in Strengthening halal Food Supply Chain for Food Industry in Malaysia (A review)," *Jurnal of Food Technology,* vol. 8, pp. 74-81, 2010.

[15]   "Perang Logo Halal Palsu," in *Myhalal* vol. 2012, ed. Malaysia, 2012.

[16]   D. M. S. Monteiro and J. A. Caswell, "Traceability Adoption at the Farm Level: An Empirical Analysis of Portuguese Pear Industry," *Food Policy,* vol. 34, pp. 94-101, 2009.

[17]   M. Bevilacqua*, et al.*, "Business process reengineering of a supply chain and a traceability system: A case study," *Journal of Food Engineering,* vol. 93, pp. 13-22, 2009.

[18]   V. Caporale*, et al.*, "Importance of the traceability of animals and animal products in epidemiology," *Rev. sci. tech. Off. int. Epiz.,* vol. 20, pp. 372-378, 2001.

[19]   G. Fenu and P. Garau, "RFID-based Supply Chain Traceability System," in *Industrial Electronics, 2009. IECON '09. 35th Annual Conference of IEEE*, 2009, pp. 2672-2677.

[20]   A. Z. Mohamed, "Title," unpublished|.

[21]   I. Nonaka and H. Takeuchi, *The knowledge creating company: how Japanese companies create the dynamics of innovation*. New York: Oxford University Press, 1995.

[22]   W. Hao-yu*, et al.*, "Apply Knowledge Management to Improve the Core Competence of the Supply Chain.," presented at the 2010 International Conference on Electronics and Information Engineering (ICEIE 2010). 2010.

[23]   F. Laakmann, "Supply Chain Engineering and the Use of a Supporting Knowledge Management Application Knowledge and Skill Chains in Engineering and Manufacturing," in *IFIP International Federation for Information Processing*. vol. 168, ed Boston: Springer, 2005, pp. 193-200.

[24]   H. Takeuchi, "The New Dynamism of the Knowledge-Creating Company," in *Japan Moving Toward a More Advanced Knowledge Economy: Advanced Knowledge—Creating Companies*, ed Washington DC: World Bank Institute, 2006.

[25]   H. Takeuchi, "The New Dynamism of the Knowledge-Creating Company: Japan Moving Toward a More Advanced Knowledge Economy: Advanced Knowledge—Creating Companies," World Bank Institute, Washington DC2006.

[26]   W. Hao-yu*, et al.*, "Apply Knowledge Management to Improve the Core Competence of the Supply Chain," in *2010 International Conference on Electronics and Information Engineering (ICEIE 2010)*, 2010, pp. 459-461.

[27]   H.-P. M. Ismail and S. Alina, "Understanding Collaboration and Supply Chain Process: A Critical Review," in *4th IEEE International Conference on Management of Innovation and Technology, ICMIT 2008.* , Bangkok, 2008, pp. 1033-1037.

[28]   X. Chunyan and Z. Yali, "The Study Of Knowledge Management Pattern In Supply Chain Enterprise," in *Management and Service Science, 2009. MASS '09.*, Wuhan, 2009, pp. 1-4.

[29]   N. Zhang*, et al.*, "Address Supply Chain Visibility from Knowledge Management Perspective," in *The IEEE International Conference on Industrial Informatics (INDIN 2008)*, Daejon, Korea, 2008.

[30]   A. S. Bollinger and R. D. Smith, "Managing organizational knowledge as a strategic asset," *Journal of Knowledge Management,* vol. 5, pp. 8-18, 2001.

[31]   J. Gong and K. Wu, "The Incentive Mechanism of Knowledge Management in Financial Industry," presented at the Second International Symposium on Knowledge Acquisition and Modelling 2009, Wuhan, China.

[32]   N. Zhang*, et al.*, "Address Supply Chain Visibility from Knowledge Management Perspective," in *The IEEE International Conference on Industrial Informatics (INDIN 2008)*, DCC, Daejeon, Korea, 2008, pp. 865-870.

[33]   M. Littlefield and M. Shah, *Management Operation Systems. The Next Generation of Manufacturing Systems*. Aberdeen: Aberdeen Group, 2008.

[34]   Z.-q. Zhang*, et al.*, "Knowledge Management in Supply Chain: Complexity and a Conceptual System Framework Based on MAS," in *Wireless Communications, Networking and Mobile Computing, 2007*, Shanghai, 2007, pp. 5333-5336.

[35]   T. L. Sporleder and L. E.Moss, "Knowledge Management in the Global Food System: Network Embeddedness and Social Capital," ed: The Ohio State University, 2002.

[36]   R.-S. Chen*, et al.*, "Using RFID Technology in Food Produce Traceability.," *WSEAS TRANSACTIONS on INFORMATION SCIENCE and APPLICATIONS,* vol. 5, pp. 1551-1560, 2008.