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From a Literature Review to a Conceptual Framework for Automation Knowledge Acquisition in Supply Chain Management

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Abstract: In supply chain management, both academic and corporate interest concerning knowledge acquisition has shown an increasing trend in the past few years. This is evidenced by the significant amount of research written and published in journal special issues. In response to this trend, the present study has two objectives-first, it offers to provide an overview of literature concerning knowledge types and knowledge acquisition in the context of supply chain management discussed in 47 papers from the years 2001-2013. Second, it develops a conceptual framework that summarizes this field of research into four parts. Initially, knowledge types and AI techniques are highlighted which leads to two specific perspectives: supply chain knowledge and automation of knowledge acquisition for supply chain management. Companies' practitioners and academics may avail of the review as it provides an overview of the fundamental research streams in the area. It then explains certain features of knowledge acquisition in the context of supply chains and the existing research limitations which could lead to future studies.

Key words: Knowledge acquisition, characteristics of knowledge, supply chain knowledge, knowledge types, artificial intelligent techniques

INTRODUCTION

Knowledge Acquisition (KA) has emerged as a key approach for Supply Chain Management (SCM) seeking to gain competitive advantage due to the fact that knowledge is a core competitive resource in today's knowledge economy. Firms in the supply chain should acquire knowledge in order to improve cooperation performance (Chen and Zhou 2011; Diugwu, 2011). Knowledge in SC has many issues like: knowledge can not be easily shared on the chains; the function of each work in the single joint enterprise can not be understood clearly and innovation in SCM is found to be limited.

Thus, there is a need for a system based on a repository used to store and classify the supply chain knowledge (Bergmann *et al*., 2003) and further studies are called for to conceive the system. The present study is an attempt to propose a knowledge acquisition framework for supply chain in food manufacturing firms. Thus, the researcher conducted a literature review in order to gather and conduct an analysis of the relevant studies in the area.

MATERIALS AND METHODS

The aim of the literature review in this research is; first, to provide a summary of the extant research according to themes, patterns and issues and second to determine the field's conceptual constituents (Meredith, 1993) that could lend hand in the development of the theory (Harland *et al*., 2006). Because literature review is considered as content analysis wherein both aspects, qualitative and quantitative are combined to assess criteria in terms of content and structure (Brewerton and Millward, 2001), researchers employed Mayring's Model which entails going through four stages:

- Stage 1: define and delimit the content to be gathered
- Stage 2: assess the quality of each material
- Stage 3: select the dimensions of structure and relevant analytical types from the gathered content
- Stage 4: analyse the materials according to the structural dimensions. In this way, relevant issues and results can be interpreted

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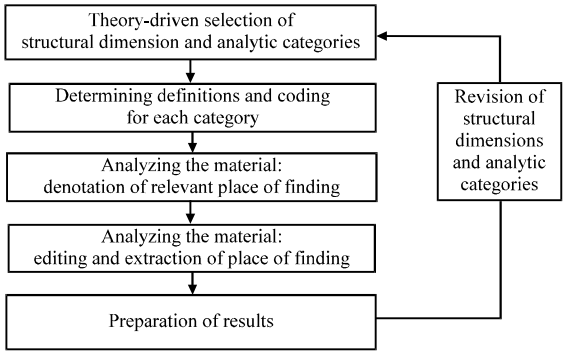

Fig. 1: The process of a structuring content analysis (Mayring, 2002)

The material analysis phases from 3-4 are presented in Fig. 1. A feedback loop is included for analysis of the content gathered as it may be required for the complete process.

In addition, both structural dimensions and the relevant analytical categories allowing categorization of the reviewed literature are obtained either inductively or deductively. In the latter approach, the dimensions and analytic categories are chosen prior to the analysis of material and in the former method, the dimensions and analytic categories are synthesized from the content through generalization. In the two cases, the dimensions and analytic categories should be clearly related to an existing theory. In the specific method selected, researchers began with various dimensions and categories and the papers were categorized according to them. In the initial part of the analysis, these dimensions and categories were revised. This method underlies the basis for the literature reviewed in this study.

Delimitations and the search for literature: Researcher conducted the search for related publications through a structured keyword search where primary databases were consulted to find related articles. These include those by major publishers like Elsevier, Emerald, Springer, Wiley or library services like Ebsco, Scopus, Metapress or Subito. Following an initial content check, articles were defined and sorted out into included and excluded articles. The research reliability was increased through the confirmation and revision of databanks, journals and individual drafts by a second researcher. As secondary source, the cited references were also reviewed resulting in only a few additional studies which indicate research validity. Based on the delimitations, 47 papers were highlighted for inclusion. The next step entails sifting based on inclusion criteria through relevant procedures.

Inclusion criteria and procedures: As mentioned, the list of studies was gathered through an in-depth search into the bibliographic sources via search keywords. This list of studies is deemed to be the fundamental study materials. This called for a screening step based on title, revision of abstract and introduction in order to develop a final list of literature. The primary aim of this phase is to select the most appropriate papers that address the research questions. Accordingly, the following criteria were utilized to cull the content of materials:

- The analysis attempts to indentify technical papers in peer-reviewed scientific journals in English
- Publications with the main topics of supply chain knowledge
- Articles focusing on acquisition of knowledge in the context of the supply chain
- Publications with the main topics of artificial intelligence application in supply chain
- Papers focusing on artificial intelligence application in supply chain knowledge

Data extraction strategy: The review considered a few relevant criteria to identify certain data types to achieve the review objectives. The considerations are divided into three streams with every stream concentrated on a specific data. These themes were:

Findings: Gathered data is of relevance to the research findings and it has research and practical implications.

Approach: Gathered data is of relevance to the employed research approach suitable for a specific study. A part from this, consideration of artificial intelligence in research approach was kept in consideration when reviewing data.

Contextual consideration: Retrieved data is of relevance to knowledge acquisition-in other words, the study should address automated knowledge acquisition in supply chain or automation supply chain or both.

Conducting the review: Searching, selection and revision of data was carried out from January 2013 to August 2013. The keywords utilized for the search in bibliographic databases and the Google site are; supply chain knowledge, knowledge acquisition, supply chain and artificial intelligence application. Additionally, manual bibliographic searchers were conducted to gather relevant papers. The initial search led to the collection of around 100 significant publications. Following the sifting of the articles based on criteria, 47 articles/publications were chosen.

Towards a conceptual framework: The initial steps of the research are explained in the first section of the draft. The review is conducted on the basis of both knowledge acquisition and supply chain management. The next step the field conceptualization which is deemed as the first step in theory development (Weick, 1995). According to Meredith (1993), this step entails the conceptualization of philosophy which is based on repetitive reading of papers. As previously mentioned, the framework is presented in four parts namely:

- Supply chain knowledge
- Knowledge acquisition in the supply chain
- Artificial intelligence application in supply chain
- Artificial intelligence application in supply chain knowledge management

Supply Chain Knowledge (SCK): In this study, the first step is to identify the knowledge types for every field and related action. This is explained in tabulated form in Table 1, with further elaboration outlined prior to going into details. Presently, various players within the global economy such as end-users, partners, providers and customers all contribute to knowledge gain efficiencies throughout a supply chain. Generally, firms examine new method to develop knowledge based on projects and consider the involvement of customers, partners and other stakeholders as they contribute relevant intellectual capital (Weick, 1995). The aim behind some studies is to examine the reasons behind the enthusiasm of companies to share knowledge with their partners throughout the supply chain. Davis and Meyer (1999) contended that knowledge and moral needs of the relationship do not just facilitate runs but they also form the product package offered by the companies. Currently, companies selling product and service always possess a set of tangible products and service moral comprising of solutions which may be considered as knowledge. In other words, these companies provide customers with product and service hybrids where their supply chain knowledge is a technical know-how of product design and marketing that encapsulates customers' preferences, personal creativity and innovation. As such, they are of utmost importance to their supply chain partners. This contention is supported by Christensen *et al.* (2005) who claimed that because of the existing global competition and continuous knowledge expansion, firms are encouraged to run based on Just In Time (JIT) and Mass-Scale-Build-to Order (MSBTO) to achieve success in facilitating their partners with the ability to achieve market requirements for greater degrees of product modification and timely recognition.

Table 1: Knowledge classification

Researchers	Characteristic of knowledge	Definition	Examples
Wadhwa and Saxena (2005) and Zhang *et al.* (2007)	Tacit knowledge	It is personal, intangible and difficult to represent and process	Culture, experience
Ge and Li (2008)	Explicit knowledge	It is a standard characteristic which is easily managed and always takes the form of business information and knowledge. Consequently, management at this level of knowledge is easy to implement	Systems, criterion and the non-secrecy documents about product design
	Innovation knowledge	It arises from the constant innovations of member firms in view of the continually changing environment	Decision
Zhang *et al.* (2008)	Quantitative knowledge	It is discovered from a supply chain's business databases through data mining	Financial situation
	Qualitative knowledge	It is experience and judgment captured from individuals in the collaborative decision making process	Judgment
Smirnov and Chandra (2000)	Reusable components	It is a common domain knowledge model such as "product-process resources	Process planning Production design
Neumann (2007)	Project specified knowledge	It is the foundation behind the project data and specifications including the design decisions that link elements of basic data, design data, project specifications, domain knowledge and general knowledge to explain the design	New capabilities
Nath *et al.* (2005)	An enterprise's knowledge domain	It is defined as critical, subcritical or common market knowledge and related to various organizational forms	Shop floor
Hall and Andriani (1998) and Meixell *et al.* (2002)	Similarly internal	Formal is a type of knowledge which includes research reports, marketing material, processes, methods, etc. Informal is the most important area and most difficult to manage. It essentially deals with tacit knowledge Organizations usually use some sort of community based electronic discussion and 'lessons learnt' databases to transfer tacit knowledge from individuals into a repository	Reports Teaching Learning
	Similarly external	It is the easiest to acquire, organize and communicate. This includes knowledge about the marketplace, competitors, customer information, etc.	Business commitment

Table 1: Continue

Researchers	Characteristic of knowledge	Definition	Examples
Sezgin and Saatcioglu (2011) and Fischer and Stokic (2002)	Technological knowledge	It covers products and processes (including patents, best practice processes)	Technology data System
	Organizational knowledge	It includes knowledge about the organization and its operations, the customer and the whole supply chain	Process improvements
	Network knowledge	It is inherent in the alliances and relationships that exist between the entities within the organization and its networks including suppliers, subcontractors and clients	Product part
Huang *et al.* (2003)	Product-Process-Resource-Inventory-Order-Planning Model	Product: describes the physical, functional and storage characteristics of a product. Process: describes the time, management and cost of a process. Resource: describes the resource of material. Inventory: describes the weather of inventory. Order: describes the basic of demand. Planning: describes the process of the plan to make a product	Physical components Reduction time Supplier risk Inventory level Order planning Demand forecasting
Keqin and Shurong (2008)	Manufacturing knowledge	It is classified into three categories which are machine, material and manufacturing processes	Production process
Deng and Peng (2008)	Supply chain knowledge	It refers to the knowledge that related to some of the categories in SC which are: external knowledge, common knowledge, specific knowledge and personal knowledge	Business commitment Production scheduling Delivery scheduling
Samuel *et al.* (2011)	Inter-organizational knowledge	It refers to the knowledge that be created through learning and acquisition in an internal organization	Customer demand Logistic provider

Characteristic of knowledge in supply chain: The supply chain comprises of the different phases that directly and indirectly contributes to the achievement of the request of customers. Hence, it covers product process beginning from the raw material to delivery of product to the user, the partners that impact the supply chain like manufacturer, supplier, transporters, retailers, customers and warehouses. All that is relevant to the supply chain has abundant and complex knowledge because of the complex environment and the exchanges that are inter-organizational. Additionally, the knowledge classification in supply chain management is the basis of the processes that take place in knowledge supply chain management. Hence, as listed in the Table 1, prior researchers have attempted to classify knowledge on the basis of their research framework. The classification of knowledge is displayed in Table 1.

It is evident from the Table 1 that various kinds of knowledge are categorized under some characteristics which are; internal-external elements, qualitative and quantitative (Zhang *et al*., 2008), knowledge characterized as a reusable element (Smirnov and Chandra, 2000), knowledge specified by project (Neumann, 2007) and other bilateral classifications within the domain of enterprise knowledge (Nath *et al*., 2005). Some other classifications proposed by Hall and Andriani (1998) and Meixell *et al*. (2002) include the division of knowledge based on internal-external criterion.

Along the same line of contention, knowledge refers to formal and informal forms. The former form refers to a type of knowledge that encapsulates research reports, marketing material, processes, methods, etc. while the latter form refers to the most critical knowledge and the most challenging to manage, i.e., tacit knowledge. Majority of organizations make use of community-based e-Discussion and lessons learnt databases for their transference of tacit knowledge from relevant personnel to a central repository, organizational, technological and a network of knowledge (Sezgin and Saatcioglu, 2011). This research classifies knowledge in Supply Chain (SC) throughout organizational boundaries into specific points. Some other studies classify knowledge on the basis of research framework.

Supply chain knowledge types: Each function of the supply chain management requires different types and function of knowledge (Almuiet and Salim, 2013). In the context of content analysis, the review led us to explore different types of knowledge that are presented in Table 2.

The literature review can be analysed based on the content analysis method by grouping studies under five SC function types namely planning (Smirnov and Chandra, 2000), production (Lin *et al*., 2002; Zagnoli and Pagano, 2001; Lin *et al*., 2002; Higgins, 2003), order (Shaw *et al*., 2003), warehousing, and transportation (combined and separately) (Neumann, 2007). Specifically, the five categories are explained in detail as.

Studies classified under planning primarily concentrated on knowledge relevant to planning which assists management's decision making process (Smirnov and Chandra, 2000; Wadhwa and Saxena, 2005;

Table 2: Modelling knowledge types based on SC functions

Researchers	Planning	Production	Warehousing	Delivery	Transportation
Ge and Li (2008)	Customer commitments	Product performance Product quality Product safety	N/A	N/A	N/A
Zhang *et al.* (2007)	Systems Criterion Culture Experience Intangible Innovate	Non-secrecy documents about product design	N/A	N/A	N/A
Wadhwa and Saxena (2005)	Decisions Order planning Transportation planning	Production design Production capacity Crate product	Inventory planning	N/A	Transportation capacity Transportation planning
Zhang *et al.* (2008)	Experience Judgment	N/A	N/A	N/A	N/A
Smirnov and Chandra (2000)	Business commitment	N/A	N/A	N/A	N/A
and Neumann (2007)	Customer value Innovation Superior performance New capabilities Formalizing experience Planning process Decision making Problem solving Learning Teaching	N/A	N/A	N/A	N/A
Fischer and Stokic (2002)	Process improvements Process planning Business process Technology data Physical components Corporate planning Process Model Technology Model Reduction time Reduction cost Experience	Production and maintenance Production Model Product part Product design Shop-floor Production process	N/A	N/A	N/A
Deng and Peng (2008),	Customer analysis	Product design Production schedule	N/A	N/A	N/A
Keqin and Shurong (2008) and Samuel *et al.* (2011)	Logistics provider Difficulties adapting Customer demand Financial situation Production planning Sales forecasts	N/A	Inventory reduction	Reliability problems with deliveries	Supplier risk
Almuiet and Salim (2013)	Business commitment	Production schedule Production improvement	Inventory level	delivery schedule	transportation schedule
Zhang and Hong (2009)	Building plans	N/A	N/A	Building demands	N/A
and Done (2011)	Coordinating Planning Demand forecast	Production plans	Inventory level	Delivery schedules Delivery frequencies	N/A

Neumann, 2007; Zhang *et al.*, 2007; Deng and Peng, 2008; Ge and Li, 2008; Keqin and Shurong, 2008; Zhang *et al.*, 2008; Zhang and Hong, 2009; Done, 2011; Samuel *et al.*, 2011; Almuiet and Salim, 2013; Fischer and Stokic, 2002). Under the classification of production, the studies focused on knowledge relevant to production-these help manufacturers in improving or maximizing production (Wadhwa and Saxena, 2005; Zhang *et al.*, 2007; Deng and Peng, 2008; Ge and Li, 2008; Keqin and Shurong, 2008; Done, 2011; Almuiet and Salim, 2013; Fischer and Stokic, 2002).

Under warehousing category, studies examined knowledge concerning warehousing that assists management in warehousing to improve the inventory case (Wadhwa and Saxena, 2005; Done, 2011; Samuel *et al.*, 2011; Almuiet and Salim, 2013).

The delivery classification encapsulates studies focused on knowledge relevant to delivery that assists delivery personnel to develop an optimum method of delivering products to end users (Zhang and Hong, 2009; Done, 2011; Samuel *et al.*, 2011; Almuiet and Salim, 2013).

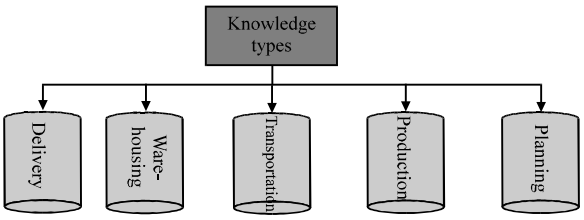

Fig. 2: Supply chain knowledge

Finally under transportation classification, the studies mainly concentrated on transportation relevant knowledge that assists transporters in enhancing, developing or improving transportation (Wadhwa and Saxena, 2005; Samuel *et al*., 2011; Almuiet and Salim, 2013).

From the above categories, we noted that majority of researchers focused on knowledge issues relating to planning compared to any other SC functions (Smirnov and Chandra, 2000; Wadhwa and Saxena, 2005; Neumann, 2007; Zhang *et al*., 2007, 2008; Deng and Peng, 2008; Ge and Li, 2008; Keqin and Shurong, 2008; Zhang and Hong, 2009; Done, 2011; Samuel *et al*., 2011; Almuiet and Salim, 2013; Fischer and Stokic, 2002). Therefore, this provided the present research motivation to focus on some other supply chain function other than planning. The supply chain types are presented as a knowledge base in Fig. 2.

Artificial intelligence techniques in supply chain: The earlier study discussed knowledge types in the supply chain. In this study, techniques applied that support such supply chain development are explored to achieve the study objectives. Two techniques are often employed for effective achievement of supply chain's goals: Intelligent Agent (IA) and Case-Based Reasoning (CBR). It is notable that the supporting techniques are evidently linked to enhancing the supply chain performance. Therefore, artificial intelligent techniques have a key role in this context. On the basis of these techniques, varying other techniques can be highlighted to contribute to the SC performance enhancement.

To summarize, two different techniques can be used for classification. For instance, Kwon *et al*. (2007) adopted the characteristic of CBR and multi-agent to enhance the information sharing and coordination with the assistance of a range of supplies and to satisfy the uncertainties of demand. They demonstrated a combination of both CBR and multi-agent based coordination techniques to enhance and generate the most optimum outcome in the supply chain. Fang and Wong (2010) integrated the intelligent agent with CBR. An intelligent agent is employed for the exchange of bargaining offers. CBR is applied in order to efficiently retrieve the suitable case from the case based. The hybrid approach brought forward makes use of the prior successful case to determine solutions for a new problem that the enterprise encounters. It offers effective adaptation algorithms to facilitate the appropriateness of the case to the new situation. Similarly, an integrated framework based on multi-agent collaboration and cased-based process of CBR was proposed by Garg *et al*. (2011). This approach which is MACESCM System is used to provide solutions that are characterized as flexible and extensible that assists in addressing supply chain management uncertainties and develops an overall multi-agent system to comprehend, control and decide on how SCM disruption can be minimized. In addition, Fu and Fu (2012) investigated the use of a combination of the CBR and multi-agents. This approach is used to solve the complexity cost of inter-organization management in supply chains. This study indicates that this approach is able to better enhance the capacity for competitiveness and to address certain issues in the cost management of the SC. Moreover, Hassan and Soh (2005) examined the potential of intelligent agent from SCM perspective, especially in supply chains web service and found that organizations SCs are riddled with various inefficiencies such as final higher product costs because of the inflexibility of the traditional supply chain architecture and its inability to configure automatism based on the dynamic business environment. Similarly, Hassan and Soh (2005) developed intelligent agent framework that is suitable for handling dynamic and adaptive supply chain integration in the context of a web-based environment. On the other hand, Zhang *et al*. (2006) adopted the characteristic of IA to enhance the corporate management's maintenance of competitiveness by developing a strong relationship with stakeholders (employees, customers and suppliers). They demonstrated that agent technology is the top choice for e-Commerce KM.

Labarthe *et al*. (2007)'s study is a response to the requirement of defining novel tools in order to design and manage complex customizing supply chains. They proposed an agent modelling framework to model and simulate supply chains for the ultimate reason of facilitating management. The proposed framework is applicable to customer-centric supply chain in golf club industry and they demonstrated a relevant experiment for customer simulation. Along the same line of study, Mogos and Socoll (2008) examined the use of IA on knowledge management in e-Business environment. The proposed approach is used to solve the complexity of the knowledge sharing in SCM. This study indicated that the

result of intelligent agent technology application on KM in e-Business shows its efficiency and effectiveness with relevant knowledge embedded in buyers and sellers. Moreover, these systems assist both buyers and sellers to keep abreast of relevant information and precipitate the process of online buying stages.

Artificial intelligence techniques in supply chain knowledge management: With regards to the importance of IA, researchers found the most common technique used for managing supply chain knowledge is IA. For instance, Wu (2001) tackled the issue of coordination among multi-agent systems. They summarized several multi-agent systems for KM and presented the coordination issue in the SC and the manner by which the design of multi-agent systems enhances information and knowledge sharing. Zhang *et al.* (2007) investigated the use of multi-agents on KM throughout the supply chain. This approach is used to solve the buyers and sellers information overload in the online buying process. They explained the complexities of KM in SCM on the basis of complexity theory as well as complex adaptive system theory. Consequently, the researchers proposed a conceptual framework based on the multi-agent system. Zhang *et al.* (2007) indicated that this approach is synthetically epistemology and multi dimension methodology. Meanwhile, Al-Mutawah *et al.* (2009) stressed on the significant of the integration of information and knowledge streams in the supply chain of manufacturing firms and discussed the crucial aspect of managing distributed knowledge. They brought forward a framework on the basis of the multi-agent systems to solve the problems arising from tacit knowledge sharing in the context of the SC of manufacturing firms. Along a similar line of study (Huang and Lin, 2010) delved into the issue of knowledge heterogeneity management in interoperability among multi-companies in one supply chain. They also proposed a solution for knowledge sharing via semantic web whereas other studies only focused on the web for information and data sharing. They based their solution on a semi-structured knowledge model to reflect knowledge in an explicit, shareable and a meaningful format in an agent-based annotation process to steer clear of knowledge heterogeneity issues. They employed an articulation technique to enhance the interoperability effectiveness existing between two heterogeneous ontologies.

Knowledge acquisition in supply chain: In the SC, knowledge acquisition is primarily referred to as generational as knowledge continuously develops from prior information and new ones collected from the surrounding. In addition, the supply chain knowledge may be developed from processes that are social and collaborative. Raisinghani and Meade (2005) contended that knowledge can be generated via particular process such as action learning involving problem solving, focusing on required learning and solutions implementation. Systemic problem solving requires a mindset that is disciplined in reductionism and holistic knowledge, attention to detail and extending the boundaries of the underlying reasons assessment. This entails learning from experience through prior company experiences, systematic assessment, shifting and recording of lessons learned in a manner that the company can fully leverage it. Following knowledge acquisition, a unified repository should be created for the collection of supply chain (Almuiet and Salim, 2013). In fact, the knowledge acquisition in the SC has its basis on every repository in the flow of supply.

Despite the fact that knowledge acquisition is important for supply chain, studies are still in the initial phase. Previous studies on knowledge acquisition in the supply chain have primarily focused on the knowledge transfers and sharing problems such as: ambiguity, optimization, reduce risk, etc. No study focused on how to actually automate knowledge acquisition in the supply chain. Only little attention has been focused on potential opportunities of automatic knowledge acquisition and cross-exploratory studies that have the potential to stem from such studies. In their attempt to create expert systems both industrial and infrastructure projects introduce a supply chain to distinct settings to facilitate ideas flow, challenges and experiences and this affords opportunities for learning and gaining new organizational capabilities. Additionally, in this inter-connected global environment, the present study has considerable list of studies and lessons that can be learned from them. The dire need for development and infrastructure coupled by a past rife with SC environmental, social and economic errors calls for a need to tackle issues with viable solutions. It calls for the commitment to learn from the past, knowledge acquisition and sharing and application of lessons learned in future projects. This is because the learning, knowledge sharing and innovation opportunities that stems from overall projects can improve the knowledge acquired in supply chain well being of firms, improving both knowledge and performance.

From a technical perspective, there is one application by Sun (2008)'s study that focused on the knowledge acquisition in the context of vegetable supply chain. This application tackles unsatisfied outcomes of retrieval, specifically in extensive database information. The application is developed based on ontology and it aimed

to adhere to the retrieval habits and timing of users to steer clear of issues of lack of intelligence in traditional methods of keywords retrieval. He highlighted the need for further researches to look into the reduction of knowledge acquisition risk. According to Ma and Nie (2009), there are only few qualitative and quantitative researches that has been done on the scope of knowledge acquisition in supply chain. Furthermore, no study has developed a framework of knowledge acquisition and its management in the supply chain.

Research dedicated to knowledge acquisition is somewhat boggled by the various labours under way that are covered under knowledge technology. Researchers have attempted with mixed outcome to make use of knowledge assets through the centralization of knowledge technology functions or through investment in information technology. When faced with novel business phenomenon, it is logical to look for knowledge techniques for resolution. The general premise is that knowledge can lead to business improvements (Choi and Lee, 2000) and thus knowledge acquisition is important. This premise should be backed by empirical research results. Nevertheless, it would more significant to differentiate them based on strategy. The main question is how to acquire knowledge as opposed to whether or not to acquire it-this also needs empirical validation.

In their attempt to minimize this gap in literature, prior studies examined knowledge acquisition for a selected problem through human experts and knowledge encoding in a computer format. There is no doubt that techniques are crucial for effective knowledge acquisition. A challenge that arises is the exploration of the acquired knowledge among SCM partners. More current empirical research has examined the acquisition of knowledge. For instance, some research focused on the factors affecting on acquiring the needed knowledge (Diugwu, 2011) while another explored the issues related to acquiring knowledge such as risk of knowledge acquisition (Ma and Nie, 2009). Sun (2008) explored the compliance of the retrieval habits of the user to overcome lack of intelligence in the traditional methods of keywords retrieval particularly in large database information.

More importantly, both researchers and practitioners have not conducted an exploration into the integrative knowledge acquisition framework although an integrative perspective of the knowledge type on the basis of artificial intelligence methods is necessary. Majority of empirical studies were also noted to employ a knowledge acquisition framework of SCM (Sun, 2008). Companies would benefit more from knowledge acquisition compared to simple knowledge contents as knowledge is not about facts but about context-centric characteristics (Lee and Choi, 2003). To summarize, the context-specific knowledge is the firm circumstances that are relevant to its primary activity. This type of knowledge can relate to various areas that are crucial to the completion of a certain knowledge activity that ranges from knowledge concerning firm strategies and goals to knowledge concerning individuals, processes, assets and firm technologies. Hence, the present study's description of context-specific knowledge is consistent with the food manufacturing firms where valuable firm-centric knowledge is required to perform tasks including production, planning, transportation, delivery and warehousing. Moreover, the role of SC knowledge, knowledge classification in SCM and the type of knowledge contained in SCM has to be determined. Knowledge acquisition has been proven to improve the capability of the firm to reuse knowledge but it is still ambiguous as to how the right knowledge can be timely obtained. The strategies of knowledge technology are considered to be very important in terms of facilitating knowledge acquisition as it determines the use of knowledge resources and capabilities (Lee and Choi, 2003).

Artificial intelligence techniques in knowledge acquisition in supply chain: Based on the significance of knowledge acquisition in supply chain as researchers mentioned in the previous study, researchers found only two papers that addressed automated knowledge acquisition in supply chain management. Specifically, Sun (2008) focused on vegetable supply chain knowledge acquisition. The mentioned application seeks concern for unsatisfied retrieval result in the verity of different situations for database information. Based on ontology, the application has been devolved and adjusted to adhere to the user's retrieval habits and timing to resolve lack of intelligence in the traditional retrieval of keywords. Researcher implored further researchers to explore ways to minimize the risk of knowledge acquisition.

In addition, Xiaodong *et al.* (2009) attempted to handle the representational ambiguities, attribute description and similarity measures of knowledge in the context of product design. To do so, a Fuzzy Case-Based Reasoning (FCBR) was created in product style extraction with the help of linguistic variables. After the product was encoded by a vector comprising of various attributes, the product morphology database was created. The product style extraction model was developed through the use of the FCBR System and the outcome was then normalized via fuzzy sets. Based on the experimental results, the FCBR Model is effective compared to other models of product form style extraction.

RESULTS AND DISCUSSION

This research explores one of the important topics in SCM and knowledge technology-knowledge acquisition within a supply chain and the framework also extends and explores the artificial intelligent techniques for this knowledge acquisition process by applying CBR and IA. The designed framework in this research will provide a knowledge types which are based on supply chain functions also allowing the supply chain members to acquire and apply their knowledge.

Conceptual framework for automation of knowledge acquisition in supply chain: A conceptual framework for Automation of Knowledge Acquisition in Supply Chain (AKASC) is proposed. This framework relies on two main parts, namely: Supply Chain Knowledge (SCK) and combination of intelligent agent with cased based reasoning to automate knowledge acquisition from the resources of the supply chain (Fig. 3).

Supply chain knowledge: The design of SCK makes up the first part of the framework. The best of automation of knowledge acquisition attempts in the SC should concentrate on identifying relevant knowledge (Wang *et al*., 2008):

- That is to be recorded, stored and reused for their optimum application advancement
- That would result in the highest value for the organization
- That would maximize the overall knowledge of the firm via the help of computer technology

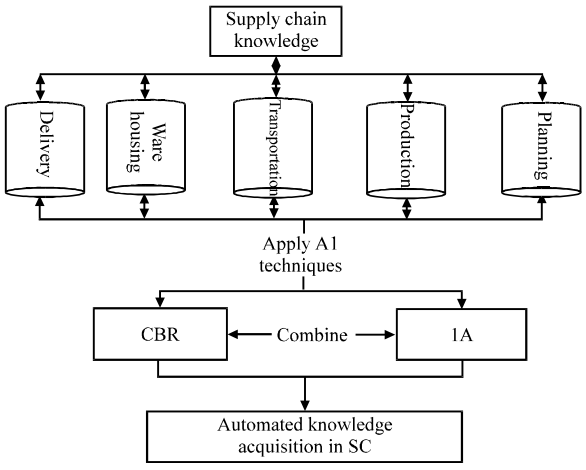

Fig. 3: Conceptual framework of AKASC

The design of the SCK considered the various functions of SC. The major goal in this part is to identify knowledge based on SC functions which can assist with other parts of the framework to obtain the right knowledge. In the context of this research, SCK is a knowledge that relates to the SC functions which are: planning, production, warehousing, delivery and transportations.

Therefore, based on the above, knowledge is needed to be modeled and stored in the knowledge base. The knowledge modelling applied to actual knowledge acquisition can be invaluable to creating knowledge. Hence, each supply chain function has its knowledge that helps in the process of making decisions. A knowledge modelling (Fig. 1) is created to develop bases of knowledge that assist SC partners to store and retrieve knowledge. In addition, the information and knowledge acquired should be recorded automatically and electronically to improve productivity and help knowledge acquisition and accumulation.

Combination of IA and CBR: Based on the suggestion brought forward in the above stage of SCK modelling, this part concentrates on the application of AI technologies to suitably reveal the domain knowledge. The knowledge representation is described as an ontological analysis of the expert's thought processes and conducting the process logically in a manner that can be programmed by the computer (Yu, 2009). It is a transition from knowledge acquisition to set of rules, facts and techniques that can be recorded by computer languages to reinforce electronic and automatic problem solutions. The knowledge representation strategies include semantic nets, frames, rules, formal logic, decision tables, case based reasoning and decision trees (Yu, 2009). Hence, it would be reasonable to employ case-based reasoning and intelligent agent to reinforce knowledge acquisition. In comparison to the traditional rule-based system, a case-based decision-support system can provide problem-solving knowledge while simultaneously providing a dependable and ever-expanding knowledge base to allow efficient knowledge retrieval and reuse for decision making (Bergmann *et al*., 2003). In brief, the combination of these techniques is expected to produce optimal results for automation of knowledge acquisition in supply chain.

This study discusses some of the most significant findings of the research that elaborate on the direction to be taken by future research. The primary contribution of this study is to provide an extensive review of peer-reviewed publications concerning knowledge acquisition in supply chain management. Three major

topics stand out in literature that calls for further emphasis: knowledge acquisition in the context of SCM has to consider a variety of issues and to examine a more expansive portion of the SC.

The above statement is highlighted as one of the most significant characteristics of automated knowledge acquisition in SCM which calls for a varied approach to carrying out future technical research. Majority of research have already addressed the automation of a supply chain (Hassan and Soh, 2005; Kwon *et al*., 2007; Fang and Wong, 2010; Garg *et al*., 2011; Fu and Fu, 2012) which although rarely done with automation of knowledge acquisition in SCM literature has relayed a dire need of studies to be dedicated to knowledge acquisition of the supply chain (Almuiet and Salim, 2013). Although, it is largely believed that knowledge acquisition can improve a firm's ability to reuse knowledge, this acquisition and its timing is still ambiguous. Strategies of knowledge technology are required to facilitate knowledge acquisition as they identify the manner to which knowledge resources and capabilities have to be utilized. In this regard, the inter-correlation among SC knowledge, classification of knowledge and system tools with knowledge acquisition arises. To date, to the researcher's best knowledge, only two studies (Sun, 2008; Xiaodong *et al*., 2009) have included the automation of KASCK in their research. As such, this implies a bigger challenge as it entails greater effort in acquiring knowledge manually. This may divert back to the notion concerning the value of automation in the reduction of effort in knowledge acquisition: automated knowledge acquisition involves a greater range of performance objectives and hence it takes the techniques and approaches of automation into consideration.

A major implication of knowledge acquisition for firms and supply chains is the extensive techniques that have to be utilized. Issues concerning acquired knowledge have showed an increasing trend in the industrial domain which indicates the need to include them in supply chain management. The argument regarding the AI techniques feasibility has been ongoing for some specific SC issues regardless of the fact that the implications of automation of knowledge acquisition in supply chain management have been largely untouched. As previously mentioned, several studies reported the impact and affect of the feasibility of AI techniques on knowledge acquisition in supply chain management. Yet, the underlying question provides opportunities for future research to explore. To reiterate, the feasibility of AI techniques with automation of knowledge acquisition in the performance management of SC provides an expansive array of research issues and these include; the shortcomings of extant research and the lack of technical background. Generally, there is lack of technical background regarding knowledge acquisition of the supply chain and from a wider perspective-for instance in knowledge repositories and knowledge flow. This is an avenue worth exploring in future studies.

More importantly, empirical research conducted in case studies and surveys require the development of a stronger theoretical basis. This should be considered as an opportunity for theory development. In the present study, the proposed framework is a step towards the theory development (Weick, 1995).

Finally, two notions should be kept into consideration; first, relevant developments development should be continued in automation of knowledge in the context of SCM. Second, academic drafts have to clarify their contentions within a specific word count in order for other authors to select empirical findings that are specific to their research as opposed to major theories.

CONCLUSION

The present study managed to provide an insight into knowledge acquisition in the context of SCM and the issues arising in the area. It also provided a conceptualization (Fig. 1 and 2) based on literature review. Having explored the types of knowledge identified by earlier researchers, this research discovered that the types of knowledge can be grouped into five categorizes based on supply chain functions namely planning, production, warehousing, delivery and transportation. This review discovered that AI techniques such as CBR and IA are most commonly employed in managing supply chain knowledge. Future studies may look into enhancing the proposed framework by examining specific sub-bodies of publications from the aspects of their research methodologies and practical perspectives as this may enable specific features detailed identification.

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