

Supply chain knowledge management: a literature review

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Abstract

This paper aims to contribute to the debate on the role of knowledge management in supply chain management by reviewing the published literature. A total of 58 selected referred journal articles were systematically analyzed. This review identifies various theoretical and methodological characteristics of the way in which knowledge management applications are proposed in the supply chain context. The review shows that little evidence exists of the positive relation between the use of IT solutions and firms' performance. Some issues remain unexplored such as the problem of knowledge obsolescence in supply chain management. A deeper understanding of the knowledge accumulation process could give new insights. The paper concludes with some future directions for theory construction and empirical research.

Keywords Supply chain management, Knowledge management, Literature Review.

1. Introduction

The aim of this paper is to evaluate the relationship between knowledge management and supply chain management through the analysis of the existing theoretical and empirical works, and to contribute to the debate on the role of knowledge management in supply chain management. Lee (2004) pointed out that efficient knowledge flows and knowledge sharing process among supply chain partners give them the following characteristics: agility, adaptability, and alignment. These characteristics allow them to be the best performers. In this paper the results of a structured review of knowledge management literature in supply chain management are presented. Based on the review of 58 journal articles, three issues are examined, (i) To which areas of supply chain management has knowledge management been commonly applied and how? (ii) How can knowledge management be applied in the supply chain management and improve it? (iii) How is knowledge management used to stimulate knowledge creation and sharing across the various supply chain stakeholders? The review of the literature has shown a growing interest in applying knowledge management in supply chains. This seems due primarily to the fragmented nature of such industry sectors and the fragmented knowledge across complex supply chains. Owing to these circumstances the main knowledge management techniques are summarized, and the knowledge management activities most commonly focused on in the supply chain are highlighted. The paper is organized as follows: section two presents the methodology used. Section three deals with the knowledge management activities identified. Sections four, five and six answer the three research questions, respectively. Finally, the key findings of the research are summarised, in the form of knowledge management trends and the main implications for academics and practitioners.

2. Material and method

Journal articles, which appeared in the period from 2000 to 2010, were collected. These articles were sourced from the ScienceDirect and ProQuest academic databases. The search was conducted using the key words “supply chain management AND knowledge management”. This very restrictive search criterion has the advantage of avoiding issues of the precise definition of knowledge management and/or supply chain management. It takes the pragmatic definitional viewpoint that an article is about knowledge management and supply chain management if its authors and journal editors think it is. However, the corresponding limitation of this kind of search is that it assumes keywords are perfect and everyone shares the same understanding of what

knowledge management and supply chain management mean. The original search yielded 57 papers; to these was added one other paper cited by one or more of the 57 and evidently also addressing knowledge management and supply chain management, according to the citing authors. This gave a final of 58 articles.

Despite the intertwined character of the knowledge management stages and activities, an effort will be made to collocate the papers on an imaginary spectrum or continuum. This may be thought in three ways. First, as running from exploitation to exploration (March, 1999), Gray (2001) used the distinction between these two concepts to categorize knowledge management practices, although exploration and exploitation should rather be viewed as the two end-points of a continuum, not as strict categories (Oshri, Pan, & Newell, 2005). Similarly, Brown and Duguid (2001) called for a re-think of the trade-off between the two. The second way is to think of the continuum as running from information and knowledge sharing to knowledge creation and development. This is similar to the first, but by no means identical with it. Thirdly, on the one hand enhancing IT solutions appear to be the most popular means to improve information and knowledge sharing. On the other hand enhancing social aspects such as communities of practices (CoPs) or trust and commitment seems to be useful to improve effective knowledge sharing and knowledge development, following the two “polar” strategies of Hansen, Nohria, and Tierney (1999). Again, this is by no means a perfect correlation with other two ways of looking at the continuum. In the next section, we use the exploitation/exploration version for the main presentation.

3. Knowledge management stages - From exploitation to exploration

3.1. Exploitation

In this section, each of the papers will be presented, starting at the exploitation or knowledge sharing/transfer end of the spectrum/continuum. The resulting classification is presented in Table I.

Briscoe, Dainty, and Millet (2001) pointed out the knowledge and skills requirements for construction supply chain partnerships. The most important types of skills used by senior executives in small and medium enterprises (SMEs) in the UK were those associated with reading and understanding technical documentation and legal contracts. The next were those linked with the formation and maintenance of main contractor and client relationships. Finally those related to teamwork within the company were highlighted. While IT and computing, as well as financial management, were low down on the rating scale of skills.

Corso and Paolucci (2001) investigated the relation between different approaches to knowledge transfer and pattern of adoption of information and communication technology (ICT) application. They also described the economic implications of these alternative approaches. No relation between ICT investments and a firm's growth was found.

Tah and Carr (2001) carried out a study for developing a sharable knowledge-driven approach to risk management. This defined generic risk and remedial action descriptive terms, which can be stored in catalogues.

Wu (2001) addressed the problem of coordination among multi-agent systems. Several multi-agent systems for knowledge management were summarized. The issue of coordination problems in supply chain was presented and how to design multi-agent systems to improve information and knowledge sharing was highlighted.

Becker and Zirpoli (2003) carried out a research on the theme of knowledge transfer in outsourcing activities. In particular, the focus was on designing an outsourcing strategy to improve knowledge integration. The decomposition strategy for managing dispersed knowledge in outsourcing activities was described through the analysis of a case study of FIAT auto case.

Choi, Budny, and Wank (2004) studied intellectual capital in the form of intellectual property management and its strategic importance in corporate success. They referred to a knowledge supply chain and models of licensing relationships. The importance of knowledge as the basis of the transaction in a licensing relationship was highlighted.

Holtbrügge and Berg (2004) carried out a study of the knowledge transfer process in German multinational corporations (MNCs). The evidence showed that the source of knowledge (external and internal) and the characteristics of knowledge flows are affected by different firm-specific and country-specific variables, such as the cultural distance between the subsidiary and the home country of the MNCs.

Sivakumar and Roy (2004) proposed the concept of knowledge redundancy as a critical factor for supply chain value creation. The concept of redundancy here does not have a negative meaning. On the contrary it deals with there being sufficient overlap of knowledge to give the opportunity to

have good communication and, thus, effective operation activities. A conceptual model for managing knowledge redundancy was proposed.

Raisinghani and Meade (2005) investigated the links between supply chain, firm's agility and knowledge management. Their focus was on the strategic decision making perspective. They provided a decision model that supports in determining the best knowledge management construct for an agile supply chain.

Douligeris and Tilipakis (2006) carried out a study on the new opportunities provided by the semantic web. They focused their attention on the introduction of web technologies on supply chain management. The use of the semantic web for improving knowledge management and the benefits of supply chain management sector were highlighted. In particular the use of ontologies in improving knowledge management applications was described.

Huang and Lin (2010) addressed the problem of managing knowledge heterogeneity in the context of interoperability among multi-entities in a supply chain. They proposed a solution for sharing knowledge using semantic web, while other studies pointed out the use of Web for sharing only information and data. Their solution was based on a semi-structured knowledge model to represent knowledge not only in an explicit and sharable, but also a meaningful format, an agent-based annotation process to resolve issues associated with the heterogeneity of knowledge documents, and an articulation mechanism to improve the effectiveness of interoperability between two heterogeneous ontologies.

Koh and Tan (2006) studied the knowledge translation process and proposed the use of a tool for action plan selection (TAPS) as a decision-making tool to enable translation of knowledge of supply chain uncertainty into business strategy and actions.

Bandyopadhyay and Pathak (2007) dealt with outsourcing activity as a means to achieving complex knowledge and competencies. Their analysis demonstrated that cooperation plays an important role in enhancing knowledge sharing between employees when there is a high degree of complementarity of knowledge. Thus the authors suggested that the role of top management in outsourcing activities is not only related to negotiating contracts, but also encouraging cooperation between employees.

Chow, Choy, and Lee (2007) developed a survey of knowledge management practices in order to examine the applications and technologies adopted in developing a knowledge management system in build-to-order supply chains.

Duanmu and Fai (2007) presented a study of the vertical knowledge transfer process to Chinese suppliers by multinational enterprises (MNEs). Types of knowledge transferred and means by which they are transferred were identified. The focus of their analysis was on the relationship created between MNEs and Chinese suppliers. The motivations of the MNEs entering China were efficiency seeking combined with market seeking motives and cost savings. From Chinese suppliers the reasons to be chosen by MNEs were: great security with respect to survival, increased sales, prestige and potential to learn.

Fletcher and Polychronakis (2007) developed a framework to capture and disseminate knowledge in the supply chain. Their empirical work was conducted on small and medium enterprises (SMEs). The framework was developed from the previous works and then empirically improved by further fieldwork within a sample of SMEs. The aim of the framework was to enable partners in the supply chain to harness and potentially disseminate skills and knowledge.

Joshi, Sarker, and Sarker (2006) examined the factors that affected the knowledge transfer process within an important social unit, the team. Their theoretical model highlighted the importance of the source's capability, credibility, and extent of communication in determining the extent of the knowledge transferred. Otherwise, capabilities did not play an important role.

Cheung and Myers (2008) addressed the main problems of sharing knowledge in global strategic networks. They considered factors that contribute to the sustainability of knowledge sharing in global supply chain. These included management fit, market-related fit, resource fit, shared identity, relational capital and flexibility.

Myers and Cheung (2008) conducted a study on how knowledge sharing provides value to buyers and suppliers in a global supply chain. The problem of knowledge sharing in such a context is more complex due to cross-cultural differences. The results showed that knowledge sharing is influenced by market structure, and organizational similarities and dissimilarities between buyers and suppliers more than by their needs. While, despite what other literature has claimed (e.g. Ford et al., 2003) cross-cultural differences rarely matter.

Wang, Fergusson, Perry, and Antony (2008) adopted a learning perspective, and emphasized the effective knowledge sharing in a supply chain. Their aim was to explore and formulate a model that supports an enterprise with its management of the supply chain members' knowledge resource sharing. They highlighted the need for mutual learning to increase the competence of supply chain partners, and presented a model for effective knowledge sharing among all partners.

Paton and McLaughlin (2008) highlighted the importance of service exchange for innovation. Service exchanges were presented as a determinant for sustainable growth. They focused their attention on the importance of knowledge transfer in SC exchange. In this case the focus was on the role of knowledge centred technological architecture in supporting knowledge workers.

Madsen, Riis, and Waehrens (2008) proposed a method for identifying hidden knowledge in outsourcing activities. This consisted of methods for identifying knowledge ties to non-normal task situations, assessing knowledge of various task situations among business partners and a method for transferring of non-normal task situations.

Al-Mutawah, Lee, and Cheung (2009) emphasized the importance of integrating information and knowledge flows within the manufacturing supply chain, and highlighted the importance of handling distributed knowledge. A framework based on multi-agent systems was proposed to address the problem of sharing tacit knowledge in the manufacturing supply chain.

Blumenberg, Wagner, and Beimborn (2009) demonstrated that the specific knowledge transfer process has a positive impact on outsourcing performance. The mechanisms mentioned were trainings, strategic level agreements (SLAs), and standards.

Fugate, Stank, and Mentzer (2009) examined the importance of knowledge management process to overall organizational performance finding that a shared interpretation of knowledge mediates how it is disseminated. A strong positive relationship was found between knowledge management process and operational and organizational performance. The study was framed in the logistic operations context.

Pedroso and Nakano (2009) dealt with the complexity and heterogeneity of information and knowledge flows within the supply chain. These were focused on technical information flow. At the

same time the importance to facilitate the punctual delivery of information among supply chain members was recognized. The study was framed in the context of the pharmaceutical industry, where punctual technical information delivery is a determinant for the efficiency of the entire process. In the light of this, particular requirements of the technical flows were highlighted. The integrated management of technical information, order information, material and financial flows was required. In addition the use of IT systems and social networks for dissemination was suggested.

Corso, Dogan, Mogre and Perego (2010) carried out a study on the knowledge management applications in the supply chain. The study focused on the food industry. They presented a framework for investigating how an IT-based solution for the supply chain fits the knowledge management need of the firms.

Pillai and Min (2010) addressed the problem of knowledge calibration. Knowledge calibration deals with the uncertainty of managing incomplete information and with the managers' confidence in the accuracy of knowledge available. They proposed a conceptual model for a firm's capability to calibrate knowledge.

Xiwei, Blein, and Kan (2010) pointed out the design issue in knowledge supply networks (KSNs). They focused their attention on the role of each member of the KSNs in providing knowledge. In particular, the role of universities and research centres as a key source of technological innovation was highlighted. In addition a risk evaluation method was illustrated.

To finish this "end" of the continuum, we review two articles where the three ways of looking at it do not yield the same categorization. Kovacs and Spens (2010) addressed the problem of knowledge sharing in and between relief supply chains. Following Hansen et al. (1999), they suggested the use of CoPs.

Khalfan, Kashyap, Li, and Abbott (2010) analyzed knowledge capture and knowledge sharing, showing that these initiatives improve the integration of construction supply chain and the production performance. Again they highlighted the role of CoPs.

3.2. Exploitation and Exploration

In the "middle" of our continuum, we review three papers. Corso, Martini, Paolucci and Pellegrini

(2001) conducted a literature review on knowledge management in product innovation. Both exploration and exploitation activities were described. They highlighted two main streams in the literature on that topic: one concerned with the scope of the knowledge creation system (single product innovation process, product innovation portfolio, relationship with external actors), the other one dealing with the knowledge management process.

Esper, Ellinger, Stank, Flint, and Moon (2010) suggested the integration of the two strategic processes, the demand-focused and the supply-focused, usually separated. They suggested this integration as the basis of a successful value creation through inter-organizational knowledge management. They went on to elaborate a framework for the integration of the two strategies through the knowledge management processes.

Halley et al.'s (2010) paper showed how supply chain management and knowledge management fit together. Despite the recognized attitude of the firm to build external networks of collaboration, the natural network of relationships existing in the supply chain itself is presented to be the best network in which knowledge sharing and creation takes place. It is worth noting that this position differs from a prediction of knowledge management theory. We refer to Granovetter's argument (1973), which emphasized more the role of weak ties in business relationships than that of the strong and formalized ties.

3.3. Exploration

Turning our focus towards exploration, and hence knowledge creation and learning, Choi and Lee (2002) studied the link between knowledge management strategy and the knowledge creation process. Based on a "skewed arc model" the study proposed that companies should align their knowledge strategies along with knowledge creation modes.

Ordonez de Pablos (2002) carried out a study on organizational learning and knowledge management in Spanish manufacturing industry from a strategic perspective. The themes of knowledge exploitation and exploration were pointed out. She suggested that knowledge strategy has to be integrated with strategic decision.

Spekman, Spear, and Kamauff (2002) analyzed which factors facilitate supply chain learning and whether supply chain performance is improved if learning is fostered. They demonstrated that there

is a link between relational variables such as trust, communication, commitment, and performance. Those characteristics seemed to lead to greater collaboration among supply chain partners.

Hall and Andriani (2003) highlighted the learning problem associated with the generation of innovation. They carried out a study on the production of new knowledge presenting knowledge management as a useful tool for identifying organizational and technical challenges.

Desouza, Chattarai and Kraft (2003) emphasized how supply chain management and knowledge management fit together. Organizations have to learn about the existing knowledge flows, and to identify the high concentration of knowledge around particular functions of the organization.

Johanson and Vahlne (2003) outlined a network model of the internationalization process of the firm. They emphasised the importance of learning from experiential relationships to achieve new business relationships that allow firm to enter new country markets, and the importance of commitment in fostering learning.

Freeman, Hutchings, Lazaris, and Zyngier (2010) emphasized the role of technological experience in knowledge development instead of the market specific experience and operation experience pointed out by Johanson and Vahlne (2003). They showed that shared technological knowledge allows rapid transfer and development of new knowledge and the drive to commercialize a product before a competitor.

Hult, Ketchen, and Slater (2004) analyzed why some supply chains perform better than others, and analyzed how knowledge development process shapes supply chain outcomes. The findings showed that chains possessing more memory tended to seek more knowledge than chains possessing less memory, and knowledge acquisition activities shaped information distribution activities.

Piramuthu (2005) proposed an automated supply chain framework. The main aim was reconfiguring the supply chain as per the dictates of order specifications. The paper dealt with the knowledge discovery methods. In particular the framework dealt with how data collected in dynamics supply chain could be used to improve supply chain performance.

Batenburg and Rutten (2003) carried out a study of a regional supply chain network, a Dutch knowledge industry cluster. The case study provided useful insight for managing innovation. The

importance of the unique contribution of a specific supplier and of creating trust in inter-organizational ties was recognized. Despite the transaction cost theories dominant in supply chain framework, more importance was given to the role of trust.

Hult, Ketchen, Cavusgil, and Calantone (2006) adopted a strategic perspective to identify the ideal profile to reach superior performance. The combination of strategy and eight knowledge elements from the literature on the resource-based view are found to be a determinant for reaching superior performance. The eight knowledge elements are: memory, tacitness, accessibility, quality, use, intensity, responsiveness, and learning capacity.

Samaddar and Kadiyala (2006) analyzed the conditions under which effective collaboration and knowledge creation take place. Their findings showed that it is important to maintain an optimal ratio between the leader's and the follower's marginal gains for the formation of and the maintenance of collaboration.

Hult, Ketchen, and Arrfelt (2007) adopted a strategic management perspective to analyze the importance of managing the knowledge development process in the supply chain through a culture of competitiveness. Their results showed that the interaction between a culture of competitiveness and knowledge development has a positive association with performance, but market turbulence may moderate this relation having a positive impact on knowledge development while a negative one on the culture-performance link. Thus if managers are confident about the market turbulence they should emphasize one of the two aspects. Otherwise they have to focus on both.

Maqsood, Walker, and Finegan (2007) presented the building of a learning chain instead of a learning organization. The main motivation was the augmented complexity of markets and organizations. The learning chains could be created through a culture of knowledge sharing across the whole supply chain. They emphasized the adoption of a knowledge advantage framework (K-Adv), a knowledge management initiative, which helps creating a culture of knowledge sharing, through which a knowledge advantage for the whole supply chain could be developed. Trust and commitment are the key concepts on which a combined knowledge strategy has to be based.

The role of trust in enhancing knowledge sharing was also assumed in the study by Cheng, Yeh, and Tu (2008) of a relief supply chain. They suggested that trust, shared values and participation are positively related with learning capacity.

Chen, Kang, Xing, Lee, and Tong (2008) proposed a model based on analytic network process (ANP) and sensitivity analysis to cope with the problem of new product development (NPD) mix selection. In a second stage strategic NPD mix selection and KM methods were integrated. A balanced scorecard evaluates the NPD mix selected. Then KM methods were used to ensure the successful execution of the NPD strategy and enhancing the knowledge conversion process.

Wu (2008) studied the four types of knowledge conversion process of the SECI model (Nonaka and Konno, 1998) in the supply chain to inquire how managers can leverage organizational conditions, technology adoption, supplier relationship management and customer relationship management in knowledge creation in a supply chain. Their results showed that each factor could play an important role in the different phases of the knowledge conversion process (SECI).

Yeh (2008) examined the knowledge intensive procurements projects. In particular they described the knowledge conversion-process and value creation in order to quantify the success of each project.

Craighead, Tomas, Hult, and Ketchen (2009) adopted an economics perspective to measure the impact of knowledge development capacity on supply chain performance. They measured the effects of innovation-cost strategy in the supply chain. They found that knowledge development capacity and intellectual capital efforts are a good complement for other supply chain strategies.

Lancioni and Chandran (2009) studied the problem of managing knowledge in an industrial market. The need to achieve shorter NPD cycles and facilitate the learning process is emphasized. They identified intellectual capital and customer relationship management systems as the most critical areas of knowledge management in order to foster exploitation of knowledge and organizational learning.

Lau, Ho, Zaho, and Chung (2009) analyzed a process mining system for supporting knowledge discovery in daily logistic operations. The system was applied to a company case and the results showed that it was capable of extracting high-quality and actionable information.

Niemi, Huiskonen, and Karkkainen (2009) pointed out the process of knowledge accumulation. They presented it as an ongoing process where the adoption of organizational processes and

inventory techniques takes place gradually. They also took into account the organizational aspect that need to be considered to support inventory management techniques. The model, tested in two case studies, was found useful in assessing the current situation on inventory management practices, identifying the development focus areas and prioritizing the development effort.

Lopez and Eldrige (2010) presented a working prototype to promote creation and control of knowledge supply chain. In particular their paper dealt with the dissemination of best practices among supply chain practitioners. A diagnosis module was designed and incorporated in a multi-user collaborative working prototype to examine user specified practices and to report a feedback to the user regarding the impact of these practices.

The aim of Niemi, Huisken, and Karkainen (2010) was to evaluate the adoption of complex practices of supply chain management. In order to do this they used the knowledge maturity model and strategies of accelerating knowledge creation as theoretical frameworks. Through the analysis of two case studies the main strategies adopted were evaluated to conclude that their selection depended on the cultural and organizational environment.

Table I – Exploitation and exploration: a continuum

Exploitation	Exploitation/Exploration	Exploration
Briscoe et al. (2001)	Corso et al. (2001)	Choi and Lee (2002)
Corso and Paolucci (2001)	Esper et al. (2010)	Ordonez de Pablos (2002)
Tah and Carr (2001)	Halley et al. (2010)	Spekman et al. (2002)
Wu (2001)		Batenburg and Rutten (2003)
Becker and Zirpoli (2003)		Hall and Andriani (2003)
Choi et al. (2004)		Desouza et al. (2003)
Holtbrügge and Berg (2004)		Johanson and Vahlne (2003)
Sivakumar and Roy (2004)		Hult et al. (2004)
Raisinghani and Meade (2005)		Piramuthu (2005)
Douligeris and Tilipakis (2006)		Hult et al. (2006)
Joshi et al. (2006)		Samaddar and Kadiyala (2006)
Koh and Tan (2006)		Hult et al. (2007)
Bandyopdhyay and Pathak (2007)		Maqsood et al. (2007)
Chow et al. (2007)		Chen et al. (2008)
Duanmu and Fai (2007)		Cheng et al. (2008)
Fletcher and Polychronakis (2007)		Wu (2008)
Cheung and Myers (2008)		Yeh (2008)
Myers and Cheung (2008)		Craighead et al. (2009)
Wang et al. (2008)		Lancioni and Chandran (2009)
Paton and McLaughlin (2008)		Lau et al. (2009)
Madsen et al. (2008)		Niemi et al. (2009)
Al-Mutawah et al. (2009)		Freeman et al. (2010)
Blumenberg et al. (2009)		Lopez and Eldridge (2010)
Fugate et al. (2009)		Niemi et al. (2010)
Pedroso and Nakano (2009)		
Corso et al. (2010)		
Huang and Lin (2010)		
Khalfan et al. (2010)		
Kovacs and Spens (2010)		
Pillai and Min (2010)		
Xiwei et al. (2010)		

4. Results

4.1 To which areas of supply chain management has knowledge management been commonly applied and how?

According to table II, the most common areas appear to be outsourcing, the construction industry, decision support, NPD, and risk management. Outsourcing activities appear to be the most popular area in which knowledge management can be applied to the supply chain.

Table II-Specific SCM areas

Specific SCM areas	References	Count
Outsourcing	Becker and Zirpoli (2003) Bandyopadhyay and Pathak (2007) Madsen et al. (2008) Blumenberg et al. (2009) Niemi et al. (2010)	5
New product development	Corso et al. (2001) Corso and Paolucci (2001) Becker and Zirpoli (2003) Chen et al. (2008)	4
Construction	Briscoe et al. (2001) Tah and Carr (2001) Khalfan et al. (2010)	3
Decision support	Raisinghani and Meade (2005) Koh and Tan (2006) Pedroso and Nakano (2009)	3
Risk Management	Tah and Carr (2001) Xiwei et al. (2010)	2
Build-to-Order	Chow et al. (2007)	1
Procurement	Yeh (2008)	1
Organizational Performance	Fugate et al. (2009)	1

4.1.1 Outsourcing

Outsourcing activities feature in five journal articles. Three of them (Bandyopadhyay and Pathak, 2007; Blumenberg et al., 2009; Niemi et al., 2010) showed an emphasis on cooperation and trust to

enhance knowledge management processes among business partners. Becker and Zirpoli (2003) pointed out the risk of hollowing out the knowledge base and suggested counter-balancing measures, such as the creation of communication structures, in order to reduce the dispersion of knowledge in the long term. Madsen et al. (2008) highlighted the importance of a method for identifying hidden knowledge in outsourcing activities.

4.1.2 New product development

NPD is another area in which firms have to cooperate in order to share knowledge, and knowledge management activities have to be developed. The literature review conducted by Corso et al. (2001) on knowledge management in product innovation described NPD as a continuous learning process rather than a sporadic event and showed it as one of the most promising areas where knowledge management could be applied. Corso and Paolucci (2001) included the NPD as a part of their analysis on the relationship between the knowledge transfer processes and ICT applications. Becker and Zirpoli (2003) included the product innovation process as part of their investigation into outsourcing in FIAT auto. Chen et al.'s (2008) highlighted the use of KM methods such as informal meeting, experience workshops and expert interviews to ensure the NPD process.

4.1.3 Construction

One specific sector, the construction industry, features in three papers (Briscoe et al., 2001; Tah and Carr, 2001; Khalfan et al., 2010). Briscoe et al. (2001) pointed out both technical and relational skills requirements as important factors for construction supply chain partnerships. Tah and Carr (2001) described a framework for project risk management in the construction supply chain. Khalfan et al. (2010) also looked at the construction industry supply chain, and emphasized the positive role of CoPs in improving the integration of construction supply chain.

4.1.4 Decision support

Decision support is also a common area in which knowledge management initiatives are applied since knowledge seeking is considered as a means to fill the gap between what decision makers know and what they need to know. Raisinghani and Meade (2005) addressed the need for a strategic decision-making tool to assist management in determining which knowledge management construct is most beneficial in the development of an agile supply chain. Koh and Tan (2006) suggested the application of a decision-making tool, namely TAPS, to enable knowledge translation. Pedroso and Nakano (2009) found that the efficient delivery of the information flows is positively related with an effective decision-making process.

4.1.5 Risk management

Two papers addressed risk management. As well as Tah and Carr (2001), Xiwei et al. (2010) pointed out the design issue in KSNs and proposed a risk evaluation method based on linguistic operators.

4.1.6 Others

Three other application areas were “one-offs”. Chow et al. (2007) studied the knowledge management system in build-to-order supply chains. Yeh (2008) evaluated the knowledge conversion effects for knowledge-intensive procurement projects. Fugate et al. (2009) focused their attention on the importance of knowledge management process to overall organizational performance.

4.2 How can knowledge management be applied in the supply chain management and improve it?

Choi et al. (2004) studied intellectual capital and described five models of licensing relationships to extract value from intellectual capital assets. They, also, highlighted the need for integrating intellectual capital licensing with the supply management function. Hult et al. (2004) showed that knowledge acquisition activities, information distribution activities and shared meaning were associated with faster cycle time. Piramuthu (2005) developed a knowledge-based framework for a dynamic re-configuration of supply chains over time. The paper showed performance improvements of the proposed adaptive supply chain configuration framework over static configurations. Hult et al.’s (2006) findings showed that the closer a supply chain matches an ideal profile of knowledge elements and strategy, the better the supply chain’s performance. Paton and McLaughlin (2008) highlighted the role of knowledge centred technological architectures and solutions in supporting knowledge workers. Esper et al. (2010) suggested knowledge management processes as the basis for the integration of the two strategic processes, the demand-focused and the supply-focused, usually separated. Halley, Nollet, Beaulieu, Roy, and Bigras (2010) suggested the management of the relationships existing in the supply chain for sharing and acquiring knowledge, instead of building external business relations.

4.3 How is knowledge management used to stimulate knowledge creation and sharing across the various supply chain stakeholders?

Two main approaches to the knowledge management process emerged in the journal articles analyzed. Those who proposed IT solutions as the main basis of every KM activities, and those

who, considered the social aspect of knowledge exchange and, to improve it, proposed the improvement of CoPs. This matches the two KM strategies proposed by Hansen et al. (1999). The second approach, focused on the social architecture of knowledge exchange, highlights the importance of trust, cooperation and communication to foster knowledge sharing and learning among actors (Johanson & Vahlne, 2003; Kovacs and Spens, 2010; Khalfan et al., 2010). As emerged in the papers on outsourcing activities the role of trust, cooperation, communication and relational variables is recognized to be a successful factor in knowledge sharing and knowledge creation process (Spekman et al., 2002; Batenburg & Rutten, 2003; Maqsood et al., 2007; Cheng et al., 2008; Niemi et al., 2010). The first approach is based on the extensive use of IT solutions and innovative techniques, such as in the case of the semantic web (Douligeris & Tilipakis, 2006; Huang & Lin, 2010). These kinds of techniques allow information and knowledge sharing as well as the integration of information flow (Pedroso & Nakano, 2009). What is interesting to note is that the choice of one technique or another is a reductionist way of studying the opportunities provided by knowledge management activities. If we look at these through the lens of the continuum adopted in this paper, between exploitation and exploration activities, they both appear a challenge for the firm. As suggested by March (1999) a balance between exploration and exploitation is the challenge of every firm. Hansen et al. (1999) also recommended that one KM strategy should be used to support the other, typically in an 80-20 split.

5. Discussion

In this paper, 58 journal articles, which appeared in the period from 2000 to 2010, dealing with knowledge management applications in the supply chain, were collected. Some observations on these journal articles are made in the following subsections.

5.1. Theoretical concerns and research methodological issue

To develop a better understanding the articles were analyzed to determine if a specific theoretical perspective was apparent. Where existing strategic and economic theories were being used they consisted of theory related to strategic management (the resource-based view and the knowledge based views of the firms). From the economic perspective, the transaction cost economic (TCE) paradigm is used, but in some cases the evidence contradicted the TCE predictions, such as in the case of the study on a regional supply network (Batenburg & Rutten, 2003), where the evidence showed that trust played a more important role than economic convenience in inter-organizational ties. From the research methodological point of view there is a very large use of qualitative methods as shown in Table III, while a minority of papers adopt the quantitative ones.

Table III Research Methods

Theoretical	Quantitative	Qualitative
Corso et al. (2001)	Ordonez de Pablos (2002)	Briscoe et al. (2001)
Tah and Carr (2001)	Spekman et al. (2002)	Corso and Paolucci (2001)
Wu (2001)	Holtbrügge and Berg (2004)	Batenburg and Rutten (2003)
Choi and Lee (2002)	Hult et al. (2004)	Becker and Zirpoli (2003)
Desouza et al. (2003)	Hult et al. (2006)	Hall and Andriani (2003)
Sivakumar and Roy (2004)	Joshi et al. (2006)	Johanson and Vahlne (2003)
Douligenis and Tilipakis (2006)	Duanmu and Fai (2007)	Choi et al. (2004)
Bandyopadhyay and Pathak (2007)	Hult et al. (2007)	Piramuthu (2005)
Chow et al. (2007)	Cheng et al. (2008)	Raisinghani and Meade (2005)
Maqsood et al. (2007)	Craighead et al. (2009)	Koh and Tan (2006)
Myers and Cheung (2008)	Fugate et al. (2009)	Samaddar and Kadiyala (2006)
Paton and McLaughlin (2008)		Fletcher and Polychronakis (2007)
Wang et al. (2008)		Chen et al. (2008)
Al-Mutawah et al. (2009)		Cheung and Myers (2008)
Lancioni and Chandran (2009)		Madsen et al. (2008)
Esper et al. (2010)		Wu (2008)
Freeman et al. (2010)		Yeh (2008)
Halley et al. (2010)		Blumenberg et al. (2009)
Huang and Lin (2010)		Lau et al. (2009)
Kovacs and Spens (2010)		Niemi et al. (2009)
Lopez and Eldridge (2010)		Pedroso and Nakano (2009)
Pillai and Min (2010)		Corso et al. (2010)
		Khalfan et al. (2010)
		Niemi et al. (2010)
		Xiwei et al. (2010)

5.2. Observations and recommendations

The literature review has shown that knowledge management is considered as a tool for supply chain integration. Despite the interest in studying IT solutions for improving knowledge sharing, the evidence of a positive relationship between their use and the success of supply chain integration is weak. The work of Corso et al. (2010) provides evidence on the role of knowledge management and IT-solutions in supply chains, through a case study. It is worth noting that Niemi et al. (2009), following Shapiro (2001), suggested the need of organizational solutions more than technical ones (Becker, 2001; Edwards, Shaw, & Collier, 2005). On the other hand some studies find positive relationships between other aspects of knowledge management and supply chain performance. Craighead et al. (2009) found such a relationship between the impact of knowledge development capacity and supply chain performance from an economic perspective.

The intertwined link between knowledge management and supply chain management is pointed out primarily by the recurrent use of the phrase “knowledge supply chain” (KSC) (Choi et al., 2004) and “knowledge supply networks” (KSN) (Xiwei et al., 2010). Both the phrases point out the need for attention to the knowledge flows among actors of the supply chain network. In particular, KSN emphasizes the role of stakeholder such as university and research centres in creating innovation, in accordance with the conception of network structure as the organizational form in which the role of each actor is important in fostering the learning process and innovation (Choi et al., 2004; Myers & Cheung, 2008; Wang et al., 2008; Lopez & Eldrige, 2010; Xiwei, 2010). On the other hand KSC appears to be an intangible and specific resource, which brings a supply chain competitive advantage. It emerges that knowledge management plays an important role in implementing supply chain management: for the integration processes, for improving collaboration, knowledge capture and knowledge organization.

There is a lack of studies measuring of the impact of knowledge management practices on the supply chain performance. A rare example on the role of knowledge management in supply chain comes from the Italian food industry (Corso et al., 2010). Corso et al. presented a framework for investigating how an IT-based solution for the supply chain fits the knowledge management need of the firms. It is possible to conclude that an attempt to measure, in a positivist sense, the influence of KM on supply chain performance is needed.

It is important to note that the studies conducted on IT solutions are not able to make a correlation between them and firm’s growth. Corso and Paolucci (2001) did not find a relation between IT adoption and firm’s growth. IT solutions do seem useful in information integration (Pedroso &

Nakano, 2009). Blumenberg et al. (2009) demonstrated the positive impact of knowledge transfer on outsourcing activities. Managerial strategies are expected always to have an impact. A more integrated combination of technology and management practices is needed. Further research on how knowledge management strategies improve supply chain performance is needed. Despite the emerging service economy contributing to changing the notion of innovation moving the attention toward intangible aspects, such as information and knowledge, only one paper were found on the service industry (Paton & McLaughlin, 2008).

It can be summarized that the learning processes, stimulated by knowledge management activities. (Hult et al., 2004; 2006; 2007) have typically been studied in accordance with a strategic management perspective. On the other hand, a more operational perspective characterizes the studies on knowledge sharing and transfer.

The knowledge accumulation process, within the supply chain, can be considered an interesting topic to understand more deeply. More research in this direction could provide the researchers with new insights in improving supply chain performance. Moreover, the fragmented nature of complex supply chains and the complex nature of knowledge, highlighted in many papers, could lead to problems of knowledge obsolescence. This is another theme where better understanding is needed. Thus the role of knowledge, within the supply chain, in achieving superior performance at the firm level needs a deeper understanding.

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