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Review

A systematic review of supply chain knowledge management research: State of the art and research opportunities



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ABSTRACT

The literature concerning the evolution of the supply chain (SC) has highlighted that supply systems have undergone massive changes. The SC is a multi-objective system (economic, productive, strategic, environmental, social, etc.) crossed by a variety of flows (financial, material, information, technology, etc.). In such a complex system, the management of the processes of adoption, creation, storage, transfer, sharing and application of knowledge appears to be the necessary response to the new challenges posed to the SC by globalization and sustainability issues. This paper provides a systematic review of knowledge management (KM) in SCs in order to identify the state of the art in the literature, highlight research gaps, and define appropriate research questions to be addressed. To this end, eighty-two papers were selected and studied in detail. The paper shows that although there are a growing number of papers addressing KM in SC, many research issues are still neglected. In particular, the paper highlights eight main gaps in the SC literature. The first three gaps concern the factors affecting the adoption, creation, storage, transfer, sharing, and application of KM practices. The next three gaps address the systems to support knowledge management. The seventh gap considers the barriers to the adoption of KM practices. The eighth gap looks at the impact of adoption of KM practices on performance. Starting from these eight gaps, nine research questions have been formulated. These research questions represent possible areas of investigation to improve the body of knowledge in the field of KM in SC.

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1. Introduction

The literature regarding the evolution of the supply chain has highlighted that supply systems have undergone massive changes (Womack et al., 1990; Van Kooij, 1991; Pickernell, 1997; Bidault et al., 1998; Kinder, 2003; Zhang, 2006).

In the 1970s, the literature was influenced by the growth poles theory (Perroux, 1961). Papers underline three main typologies of supplying: customer acquisition of additional labour capacity from suppliers (capacity supplying); suppliers providing the customer with new techniques (specialization supplying); and contracting out of design, methods, development and manufacturing (supply-type supplying) (Sallez, 1975; Chaillou, 1977; Berthomieu et al., 1983; Imrie and Morris, 1992). In the 70s, the supply system was a star-shaped organization characterized by direct relationships between customer and suppliers.

In the 1980s, the literature was influenced by the transaction costs theory (Williamson, 1979; Williamson, 1985), the theory of the firm as a set of contracts (Klein et al., 1978) and co-operative game theory of the firm (Aoki, 1984). The papers devote much of their attention to the Japanese industrial system, based on well-developed supply relationships (Minato, 1992; Lecler, 1992). Supply systems evolved towards a pyramidal organization structure and mutual trust between customer and first-tier suppliers, which developed through shared knowledge and the exchange of information, at the basis of the organizational and cultural changes associated with the development of the new customer-supplier relationships (Asanuma, 1989; Sako, 1992; Lamming, 1993).

In the 1990s the literature on customer-supplier relationships was affected by the debate on strategic alliances (Contractor and Lorange, 1988). Supply systems were characterized by an intense network of collaborative/competitive relationships between firms (De Toni and Nassimbeni, 1995; Wong, 1999), which involved the entire supply system (Speakman et al., 1998; McIvor, 2000). Supply systems had a pyramidal organization co-ordinated by the customer (customer visible hand). Relationships could be represented by a variety of actions driven by the customer, which encouraged the circulation of knowledge within the system, eased the innovation process, and reduced the opportunism of individual suppliers (Hines, 1994; Colombo and Mariotti, 1998).

In the early 2000s, supply systems were strongly influenced by the phenomenon of globalization. The literature was also influenced by the debate on extended enterprise and virtual enterprise (Kornelius and Wamelink, 1998; Browne and Zhang, 1999; Kinder, 2003; Esposito and Evangelista, 2014). Many authors highlighted both the impact of globalization on the supply chain and the forces that drove firms towards globalization (Arnold, 1999; Levy and Grewal, 2000; Quintens et al. 2006; Gelderman and Semeijn, 2006). Many authors stressed the importance of control factors influencing procurement, processing and distribution by means a suitable information system (Prasad and Sounderpandian, 2003). Knowledge management (KM) was an increasingly critical factor in governing supply systems (Sweeney et al., 2005; Yang et al., 2009; Blome et al., 2014).

In the last decade, supply systems appeared to be affected by the debate on sustainability. Due to more stringent environmental requirements affecting manufacturing production, increasing attention was given to developing environmental management strategies for the supply systems (Vachon and Klassen, 2008;

Seuring and Müller, 2008). The literature on supply chain was influenced by the debate on the circular economy. Many authors stressed that green supply systems based on the circular economy offered new opportunities and represented a new view for sustainable manufacturing (Zhu, 2006; Park et al., 2010; Dhakal et al., 2016; Whinkler, 2011; Zhu et al., 2011). New concepts such as the resilient supply system, the risk supply system, the green supply chain, the financial supply chain, and circular supply system began to spread, which highlighted that the supply chain is a complex circular process where a relevant role is played by the circulation of information and knowledge (Dao et al., 2011; Schrettle et al., 2014).

Today the supply chain is a multi-objective system (economic, productive, strategic, environmental, social, etc.) crossed by a variety of flows (financial, material, information, technology, etc.). In such a complex system, management of the processes of adoption, creation, storage, transfer, sharing and application of knowledge appears to be the necessary response to the new challenges posed to the supply chain by globalization and sustainability issues. Nevertheless, although there is a vast literature highlighting that knowledge management (KM) is becoming a key strategic factor in the new industrial environment, in the field of supply chain management the role of knowledge management still seems to be neglected. This latter point is also underlined by the two literature reviews dealing with the issue of knowledge management in the supply chain. The first is that of Martin et al. (2006), which reviews 36 papers on knowledge management practices in the sustainable supply chain. Authors analyse the extent to which knowledge management practices support sustainable competitive advantage. The literature is analysed from four perspectives: the reasons knowledge management enables sustainability of business competitiveness; knowledge management practices in the supply chain; knowledge management in supply chain alliances and networks; knowledge management in hard and soft supplier networks.

Marra et al. (2012) review 58 papers. The aim is to evaluate the relationship between knowledge management and supply chain management. The review analyses knowledge exploration and exploitation processes in some areas of supply chain management and identifies different theoretical and methodological characteristics concerning the way knowledge management applications are proposed in the context of the supply chain. The review also shows that there is little evidence for the positive relationship between the use of knowledge management practices and firms' performance.

Both these reviews highlight an increasing interest in the application of knowledge management practices in the supply chain. Nevertheless, they do not analyse the literature highlighting the specificity of the diverse phases of the KM process (adoption, creation, storage, transfer, sharing and application) and do not indicate whether the unit of analysis concerns customer-supplier dyadic relationships or supply chain relationships.

However, these two analytical perspectives are crucial and highlight important additional issues. In fact, the factors affecting the adoption of KM practices in the various phases of the knowledge management process are not necessarily the same. Even the systems of knowledge management (KMSs) used are different (i.e.: crowdsourcing systems concern the phase of creation, whereas the database and data warehouse concern the storage phase). As for

the unit of analysis, the relationship between customer and first-tier supplier is different (in terms of exchange of information and knowledge) from the relationship between first-tier supplier and second-tier supplier (Hines, 1994; Esposito and Passaro, 2009). Moreover, within the supply chain, the first-tier supplier plays a central role since it develops relationships with the customer upstream and downstream with the second-tier supplier. Consequently its behaviour, together with that of the customer, affects the characteristics of the supply chain. In other words, the supply chain is not the sum of dyadic relationships, and the problems of KM regarding the supply chain as whole are not the sum of the ones concerning dyadic relationships. This approach is in line with the definition of supply chain management (SCM) provided by Stock and Boyer (2009) as a network of supply relationships including the vertical relationships that exist between the company and a single or multiple customers and suppliers, and the horizontal relationships between suppliers.

In this context, the main aim of this paper is to provide a comprehensive systematic review of knowledge management in the field of the supply chain that is complementary to the two previous literature reviews. It considers three perspectives at the same time: the unit of analysis (dyadic relationship, supply network), the phases of the KM process (adoption, creation, storage, transfer, sharing, and application), and the topic area (factors affecting KM, KMSs, barriers to the adoption of KM, and KM and performance). We have chosen a systematic review approach over other survey or review approaches because of its replicable and transparent process, which helps to minimize bias in the results. This paper has three main objectives. The first is to offer an analytical overview of the existing research in the field of investigation. The second is to carry out a detailed analysis of the main issues covered by research on knowledge management in the supply chain context. The third is to identify research gaps in the literature as well as to define appropriate research questions to address. These research questions represent possible areas of investigation to improve the body of knowledge in the field of knowledge management in the supply chain context.

The paper consists of five sections. After the introduction, in the second section the methodology is illustrated. The paper selection phase is shown in the third section. The fourth section is dedicated to the descriptive and content analysis phase. Lastly, the conclusions and implications are set out.

2. Methodology

In this paper we propose a systematic review of knowledge management in the supply chain. A systematic review is an overview of primary studies that use explicit and reproducible methods (Greenhalgh, 1997).

According to Greenhalgh, Pittaway et al. (2004) propose a systematic literature review organised into ten steps: the identification of key words; the construction of search strings; initial search and identification of further key words; the selection of the citation databases; a review of the selected citation databases using the search strings; a review of the citations identified according to the inclusion and exclusion criteria; a review of the citation abstracts and separation into different lists; encoding the abstracts according to their content; a review of significant papers; added or additional papers according to professional recommendations and references from reviewed papers.

Petticrew and Roberts (2006) define a systematic review as a “review that strives to comprehensively identify, appraise and synthesize all relevant studies on a given topic” and suggest a review process organised into 12 steps: define the question; consider drawing together a steering or advisory group; write a

protocol and have it reviewed; carry out the literature search; screen the references; assess the remaining studies against the inclusion/exclusion criteria; data extraction; critical appraisal; synthesis of the primary studies; consider the effects of publication bias, and other internal and external biases; writing up the report; wider dissemination.

Easterby-Smith et al. (2012) identify two main processes of a systematic review. The first consists in defining the review protocol and mapping the field by accessing, retrieving and judging the quality and the relevance of studies in the research field under investigation.

The second describes findings to identify gaps in the existing body of knowledge. The authors suggest five stages in carrying out a systematic review: planning the review; identifying and evaluating studies; extracting and synthesising data; reporting; utilising the findings.

Summarising the above contributions, our literature review is organised into two main phases that in their turn are divided into two steps:

1. Phase of papers selection:
 - a. Material comprehensive search. This step includes the identification of key words, construction of search strings, choice of databases to be investigated (Scopus, Web of Science, etc.), review of the databases using the search strings.
 - b. Selection of papers to be analysed in detail. This step includes the definition of criteria for inclusion/exclusion and the process of selection according to the criteria of inclusion/exclusion.
2. Phase of descriptive and content analysis of the selected papers:
 - a. Descriptive analysis. The papers are aggregated according to different perspectives to give a summary view of the selected papers.
 - b. Content analysis. Papers are reviewed and studied in depth. The analysis of papers highlights strengths and weaknesses in the literature, evidences research gaps and identifies appropriate research questions to investigate.

3. Paper selection phase

3.1. Material comprehensive search

In order to provide a high level of rigorousness, the search is conducted using two databases (Scopus, Web of Science) from 1960 until 2014. A set of selected keywords such as “supply chain”, “suppl*” and “subcontr*” is used in combination with “knowledge management”, “KM”, “knowledge creation”, “knowledge storage”, “knowledge sharing”, “knowledge transfer”, “knowledge application”. The use of keywords such as “suppl*” “subcontract*” makes it possible to select papers containing the terms “supply”, “supplying”, “supplier”, “suppliers”, “subcontract”, “subcontracting”, “subcontractor”, “subcontractors”. Initially, 529 hits in total are found in two databases, as shown in Table 1.

3.2. Selection of papers

In order to focus on the research products closer to the topic under investigation, three criteria for the inclusion/exclusion of research products were defined as shown in Table 2.

The *first criterion* follows the approach proposed by Pittaway et al. (2004). It makes it possible to select only those papers whose abstracts focus on knowledge management in the context of the supply chain. In order to achieve this objective, abstracts of the

Table 1
Material search.

Keywords used	("supply chain" OR "suppl*" OR "subcontr*") AND ("knowledge management" OR "KM" OR "knowledge creation" OR "knowledge storage" OR "knowledge sharing" OR "knowledge transfer" OR "knowledge application")
Date range	Published from 1960 to present
Scopus database	441 hits
Web of Science database	226 hits
Total hits retrieved in two databases	667
Duplicates	138
Number of hits excluding duplicates	529

Table 2
Criteria for inclusion/exclusion.

First criterion: focus of the abstracts	Abstracts focusing on supply chain and knowledge management have been included
Second criterion: focus of the papers	Papers focusing on supply chain and knowledge management have been included
Third criterion: cited references	Papers not included in Scopus and Web of Science but cited in the literature on knowledge management have been included

529 papers were read in parallel by two researchers, plus a third one in case of uncertainty. In accordance with Petticrew and Roberts (2006), Easterby-Smith et al. (2012) and Pittaway et al. (2004) papers were categorized into the following three lists as shown in Table 3:

- List A includes papers with a focus on both supply chain and knowledge management.
- List B includes papers with a prevalent focus on knowledge management but scarce or insignificant reference to the supply chain.
- List C includes papers with a predominant focus on the supply chain, but scarce or inconsiderable reference to knowledge management.

The papers contained in List C (280 papers) and List B (162 papers) were excluded as they were beyond the scope of the research. The 87 papers contained in List A were considered in full and subjected to the second criterion to be analysed in detail. The *second criterion* is related to the focus of the paper. For this purpose, papers were read in full by two researchers. The phase of in-depth reading allowed us to exclude 11 papers (out of 87) not focused on the research topic.

The *third criterion* concerns references cited in the literature analysed but not included in Scopus and Web of Science. Six additional papers were identified. Therefore, the papers selected for the subsequent phase of descriptive analysis are 82.

Table 3
First step selection.

List	Description	Number of papers
C	Papers with a predominant focus on supply chain but scarce or inconsiderable reference to knowledge management	280
B	Papers with a prevalent focus on knowledge management but scarce or insignificant reference to supply chain	162
A	Papers with a focus on both supply chain and knowledge management	87
Total		529

4. Phase of descriptive and content analysis

4.1. Descriptive analysis

The descriptive analysis of the papers aims to give a general view analysis of the papers that deal with the topic of knowledge management in the context of supply chain. For the evaluation of the 82 selected papers six perspectives were identified:

1. Papers over time.
2. Papers across journals.
3. Papers by methodology.
4. Papers by unit of analysis.
5. Papers by topic area.
6. Papers by KM process.

4.1.1. Papers over time

According to distribution over time (Fig. 1), a significant percentage of papers belongs to the years 2014 and 2015 with 16 and 11 papers respectively. Specifically, there are 13 papers written from 2000 to 2005, 29 papers from 2006 to 2010, 40 papers from 2011 to 2015. The trend of papers on this topic is therefore one of growth in recent years.

4.1.2. Papers across journals

Using the functionalities provided by the SCImago Journal Rank (SJR) platform, ten journal subject areas have been identified (Table 4): "Agricultural and Biological Sciences", "Business, Management and Accounting", "Decision Sciences", "Engineering", "Computer Science", "Social Sciences", "Economics, Econometrics and Finance", "Environmental Science", "Materials Science", "Multidisciplinary".

Table 4 highlights two main aspects. Firstly, although most of the papers focusing on knowledge management in the supply chain are placed in the subject area of "Business, management and accounting", it is evident that this is a crossroads research topic, which involves a variety of journals that focus on different subject areas. Secondly, knowledge management in supply chains is a research area still neglected not only by supply management journals (9 papers out of 82), but also by knowledge management journals (4 papers out of 82).

4.1.3. Methodology

As for the research methodology adopted, the vast majority of papers are based on quantitative methodologies, with few papers using qualitative, conceptual or mixed approaches (Fig. 2).

The fifty-one papers based on quantitative methods are divided into 42 surveys, 5 mathematical models, and 4 simulation models. Regarding the 42 surveys, there are 4 different ways of collecting data: e-mail (30), online form (5), face-to-face (5) and by telephone (2). The low occurrence of the face-to-face mode identifies a significant literature gap for a qualitative topic such as knowledge management in the supply chain.

The fourteen papers based on qualitative methods are single (3) or multiple (11) case studies.

The thirteen conceptual papers are based on previous theoretical approaches and do not use empirical data but secondary data

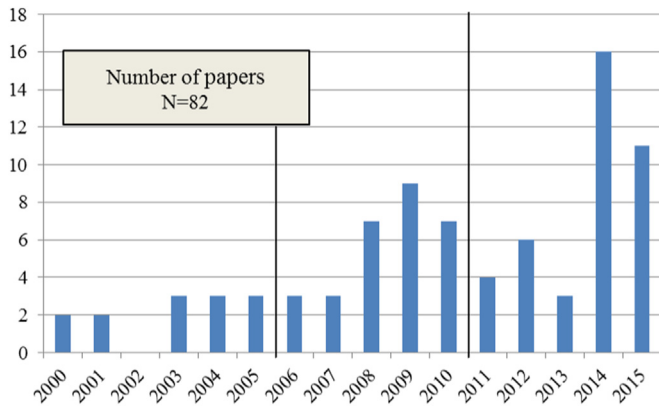


Fig. 1. Paper distribution over time.

and information.

The four papers based on mixed methods combine qualitative and quantitative methodologies.

4.1.4. Unit of analysis

Over the last few years, an increasing amount of research on supplying has enlarged the object of investigation from the simple customer-supplier relationship to the network, including supplier-supplier relationships. Wilhelm (2011) underlines that these supplier-supplier relationships constitute a missing link between the traditional supply chain analysis that focuses on the customer-supplier dyad and the concept of supply network. Stock and Boyer (2009) define supply chain management as the management of a supply network of internal and external relationships between interdependent firms and business units that support the forward and reverse flow of materials, information, services and finances from the original supplier to final customer in order to achieve customer satisfaction. The supply network includes the vertical relationships that exist between the firm and a single or multiple customers and suppliers, and the horizontal relationships between suppliers. These types of supply relationships identified are used as an analytical perspective to conduct our systematic review.

In line with this approach, papers are divided into two categories:

1. Papers analysing exclusively the dyadic relationship between customer and supplier.
2. Papers analysing the supply network.

A large part of the selected papers focus on the dyadic relationship (58) whereas 24 papers address the supply network (Fig. 3).

Intersecting the two “unit of analysis” and “methodology” perspectives, it emerges that among the 51 papers that adopt quantitative methodology, 40 papers investigate the dyadic relationship between customers and suppliers and 11 papers investigate the supply network. Even in the case of qualitative methodologies, there is a prevalence of papers focusing on the dyadic relationship between customer and supplier rather than the supply network (Table 5).

Summarising, the taxonomy of papers by unit of analysis and methodology shows two main characteristics:

1. a prevalence of papers dealing with the dyadic customer-supplier relationship;
2. a prevalence of quantitative approaches compared with the qualitative and conceptual approaches.

4.1.5. Topic area

Papers are clustered according to 4 topic areas identified in order to obtain a full overview of the problem:

1. “Factors affecting knowledge management”, in which the main drivers related to the introduction of knowledge management in a supply chain are identified.
2. “Knowledge management systems” (KMSs), in which appropriate tools and practices facilitating knowledge management in the supply chain are analysed.
3. “Barriers to the adoption of knowledge management”, in which the main obstacles related to the introduction of knowledge management in supply chain are described.
4. “Knowledge management and performance”, showing the relationship between knowledge management and supply chain performance.

Table 6 highlights that the topic area with the highest number of papers (34) is “factors affecting knowledge management”, while “knowledge management and performance” includes 31 papers; “knowledge management systems” includes 15 papers, and “barriers to the adoption of knowledge management” includes 2 papers. This seems to be a relatively unexplored topic area.

4.1.6. Knowledge management process

In line with Wiig (1997), Bhatt (2000), and Wong and Aspinwall (2005, 2006), the process of knowledge management has been divided into two main macro-processes: knowledge management adoption, and knowledge management development. The latter has in turn been subdivided into five phases (creation, storage, transfer, sharing, and application) according to Money and Turner (2007) and Nikabadi (2014b). Upon these premises, papers are clustered according to knowledge management processes:

- Knowledge management adoption in which principles for managing knowledge are introduced into the organization.
- Knowledge management development, which consists of all the systematic activities that the organization uses to create, store, exchange (transfer and sharing) and apply knowledge.

The process of “knowledge management development” is categorised into 5 different phases (Table 7): knowledge creation, in which different types of knowledge are acquired (19 papers); Knowledge storage, in which different types of knowledge are retained (8 papers); knowledge transfer, in which an actor transfers knowledge to another actor (21 papers); knowledge sharing, in which two actors exchange and share different types of knowledge (43 papers); knowledge application, in which different types of knowledge are used (7 papers).

The process of “knowledge management adoption” includes only 11 papers.

4.2. Content analysis and results

The content analysis of the 82 papers aims to give a detailed analysis of the issues covered by the literature on knowledge management in the supply chain context. Three content perspectives are identified: the topic area (factors affecting KM, KMSs, barriers to adoption of KM, KM and performance); the knowledge management process, namely KM adoption and KM development (creation, storage, transfer, sharing and application); the unit of analysis (customer/supplier relationship and supply network).

According to the topic area and knowledge management process, six areas were identified (Table 8):

- Area 1: Factors affecting knowledge management adoption (6 papers).

Table 4
Paper distribution by journals.

Journal	Journal subject area	Journal subject area									Number of papers	
		Agricultural and biological sciences	Business, management and accounting	Decision sciences	Engineering	Computer science	Social sciences	Economics, econometrics and finance	Environmental science	Materials science		Multidisciplinary
AMJ	Academy of Management Journal		x									1
ASCJ	Applied Soft Computing					x						1
BPMJ	Business Process Management Journal		x									1
CEA	Computers and Electronics in Agriculture	x				x						1
ECRA	Electronic Commerce Research and Applications		x									1
EJB	Euromed Journal of Business		x					X				2
EJOR	European Journal of Operational Research			x								1
EJPSM	European Journal of Purchasing and Supply Management		x									1
ESA	Expert Systems with Applications					x						3
FTEE	Fibres and Textiles in Eastern Europe		x		x				x		x	1
GSJ	Global Strategy Journal		x					X		x		1
IMM	Industrial Marketing Management		x									4
IM	Information and Management		x									3
ISR	Information Systems Research							x				1
IJBIR	International Journal of Business Innovation and Research		x									1
IJIM	International Journal of Information Management		x									5
IJKMS	International Journal of Knowledge Management Studies		x	x		x						1
IJLM	International Journal of Logistics Management		x					x				2
IJMMDM	International Journal of Management and Decision Making			x								1
IJNVO	International Journal of Networking and Virtual Organisations		x	x		x						1
IJPDLM	International Journal of Physical Distribution and Logistics Management		x									1
IJPE	International Journal of Production Economics			x	x			x				7

Area 2: Factors affecting knowledge management development (28 papers).
 Area 3: Knowledge management systems to support knowledge management adoption (3 papers).
 Area 4: Knowledge management systems to support knowledge management Development (13 papers).
 Area 5: Barriers to the adoption of knowledge management (2 papers).
 Area 6: Knowledge management development and performance (57 papers).

Areas 1, 2 and 3 are in turn divided into two subareas according to the unit of analysis (customer/supplier, supply network). Areas 2, 4, and 6 into ten subareas, considering both the unit of analysis and the phases of knowledge management development (creation, storage, transfer, sharing and application).

These six areas are analysed in the following paragraphs.

4.2.1. Factors affecting knowledge management adoption (Area 1)

The first area includes 6 papers and deals with factors that might positively influence knowledge management adoption. Specifically, five papers deal with the dyadic relationship (Bustinza et al., 2010; Liu et al., 2014; Mak and Ramaprasad, 2003; Patil and Kant, 2014a; Sudhindra et al., 2014), and one paper focuses on the supply network (Loke et al., 2012).

As for the dyadic customer-supplier relationship, Mak and Ramaprasad (2003) introduce the concept of “Knowledge Supply Network” defined as a knowledge-based set of competencies used to design and deliver final products or services to the market. Liu et al. (2014) analyse the knowledge chain management framework to support integrated decisions taking into consideration knowledge of the global market, global capacity and global supply network configuration. Bustinza et al. (2010) conduct a survey on a sample of 204 supply firms to show how the nature of the knowledge associated to the outsourced activities in terms of collaborative know-how and learning capability influences the process of outsourcing. Patil and Kant (2014a) develop a case study analysis to demonstrate the applicability of their prediction framework for the adoption of knowledge management in supply chains based on fuzzy multi-criteria decision-making (FMCDM), a fuzzy decision-making trail, and the evaluation laboratory (Fuzzy DEMATEL). The main findings highlight that the most important critical success factors for KM adoption are communications among supply chain members, senior management support and employee involvement. Sudhindra et al. (2014) use a morphological approach to demonstrate that there are nine knowledge dimensions (i.e. purpose, tacitness, strategic value, shareability, complexity, dependence on system, evidence, time, and measurability) acting as critical success factors for the adoption of KM in SCs.

As for the papers focusing on supply network, Loke et al. (2012) highlight that the adoption of Total Quality Management can have an effect on the knowledge management and learning ability of the entire supply network to create organizational units responsible for overseeing the management of knowledge.

Both the papers focusing on the dyadic relationship and the papers focusing on the supply network analyse only some specific factors (Knowledge Supply Network and Total Quality Management), but do not offer a clear and exhaustive framework of the set of factors that affect the adoption of KM practices. This point highlights the need for a systemic approach to identifying and analysing the set of factors that influence the adoption of knowledge management, both in the supply network and in the dyadic relationship.

In summary, this piece of literature points out the need for a more comprehensive analysis of the factors affecting the

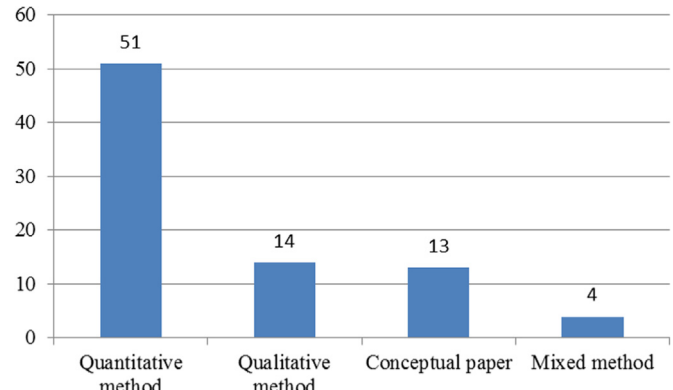


Fig. 2. Paper distribution by methodology.

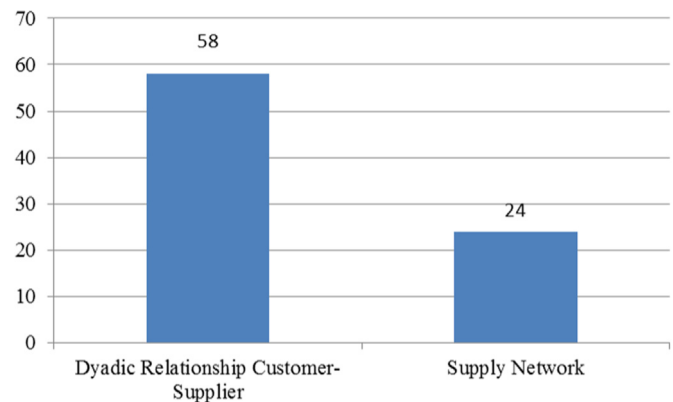


Fig. 3. Paper distribution by unit of analysis.

adoption of knowledge management practices both in the dyadic relationship and in the supply network (first gap).

This gap is particularly relevant since the adoption of KM practices, especially those acquired within the supply chain community, facilitates the processes of quasi-integration (Houssiaux, 1957; Blois, 1972) among supply chain firms that in turn generate relationships based on reciprocal trust (Lamming, 1993). So, addressing this issue may contribute not only to identifying the set of factors that affect the adoption of KM practices, but also to interpreting the mechanisms that generate synergy among supply chain firms that create the condition for long term relationships between customer and first-tier supplier and between first-tier supplier and second-tier supplier.

4.2.2. Factors affecting knowledge management development (Area 2)

The second area includes 28 papers, and deals with key factors that might affect knowledge management development. Specifically, there are 23 papers focus on the dyadic relationship and 5 papers on supply network.

Concerning the customer-supplier dyadic relationship, three papers regard the knowledge creation phase (Breite and Koskinen, 2014; Li et al., 2011; Samuel et al., 2011), one paper deals with knowledge storage (Nikabadi, 2014a), nine papers focus on knowledge transfer (Blome et al., 2014; Khan et al., 2015a, 2015b; Kim et al., 2012; 2015; Lee et al., 2009; Paton and McLaughlin, 2008; Tatikonda and Stock, 2003; Zhang and Zhou, 2013), and ten papers deal with knowledge sharing (Chen et al., 2014; Cheng et al., 2008; Cheng, 2011; Cheng and Fu, 2013; Cheung et al., 2010; Hernandez-Espallardo et al., 2010; Ke and Wei, 2007; Liu et al., 2015a, 2015b; Luo et al., 2009).

Li et al. (2011) provide a conceptual model for examining the effects of cooperation and conflicts between customer and supplier as two key aspects affecting manufacturers' knowledge

Table 5
Taxonomy of papers by unit of analysis and methodology.

	Quantitative methodology	Qualitative methodology	Mixed methodology	Conceptual paper	Total
Dyadic relationship customer-supplier	40	9	2	7	58
Supply network	11	5	2	6	24
Total	51	14	4	13	82

Table 6
Papers by topic area.

Topic area	References	
1. Factors affecting KM	Blome et al. (2014) Breite and Koskinen (2014) Bustanza et al. (2010) Chen et al. (2014) Chang et al. (2012) Cheng et al. (2008) Cheng (2011) Cheng and Fu (2013) Cheung and Myers (2008) Cheung et al. (2010) Desouza et al. (2003) He et al. (2013) Hernandez-Espallardo et al. (2010) Ke and Wei (2007) Khan et al. (2015a) Khan et al. (2015b) Kim et al. (2012)	
	Kim et al. (2015) Lee et al. (2009) Li et al. (2011) Liu et al. (2014) Liu et al. (2015a) Liu et al. (2015b) Luo et al. (2009) Loke et al. (2012) Mak and Ramaprasad (2003) Nikabadi (2014a) Patil and Kant (2014a) Paton and McLaughlin (2008) Rajendran and Rajagopal (2015) Samuel et al. (2011) Sudhindra et al. (2014) Tatikonda and Stock (2003) Zhang and Zhou (2013)	
2. KMSs	Al-Mutawah et al. (2009) Bernstein et al. (2015) De Vries and Brijder (2000) Douligeris and Tilipakis (2006) Goel et al. (2005) Huang and Lin (2010) Kovacs and Spens (2010) Malhotra et al. (2005)	Malhotra et al. (2007) Martin et al. (2008) Reyes et al. (2015) Shih et al. (2012) Wang et al. (2008) Wu (2001) Zahay and Handfield (2004)
3. Barriers to the adoption of KM	Patil and Kant (2014b) Patil and Kant (2014c)	
4. KM and performance	Abid and Ali (2014) Briscoe et al. (2001) Cantor et al. (2014) Dyer and Hatch (2006) Dyer and Nobeoka (2000) Esper et al. (2010) Fletcher and Polychronakis (2007) Fugate et al. (2012) Halley et al. (2010) Handfield et al. (2015) He et al. (2013) Hernandez-Espallardo et al. (2010) Hult et al. (2004) Hult et al. (2006) Kanat and Atilgan (2014) Lakshman and Parente (2008)	Lingegård and Lindahl (2015) Liu et al. (2012) Lu et al. (2014) Paulray et al. (2008) Pedroso and Nakano (2009) Raisinghani and Meade (2005) Rollins et al. (2011) Sambasivan et al. (2009) Sangari et al. (2015) Saxena and Wadhwa (2009) Schoenherr et al. (2014) Sivakumar and Roy (2004) Tseng (2009) Tseng (2014) Yang et al. (2009)

creation processes. Samuel et al. (2011) develop a model based on Nonaka's four stage spiral model (SECI) to analyse the knowledge creation phase. The authors identify the critical success factors affecting knowledge creation during each stage of the knowledge spiral (socialization, externalization, internalisation, combination).

Lee et al. (2009) analyse the process of knowledge transfer and point out that equipment quality, production technology, service level, cost management and execution are the most important factors affecting knowledge transfer. Kim et al. (2012) show that overall inter-organizational trust and knowledge complementarity promote knowledge transfer behaviour in a supply channel. Zhang and Zhou (2013) describe how the mechanisms of informal relationships, such as trust, and the mechanisms of formal relationships, such as contracts and controls, affect knowledge transfer in the customer-supplier relationship. Tatikonda and Stock (2003) analyse how the environmental context affects knowledge transfer (technology uncertainty, inter-organizational interaction and product technology transfer effectiveness). Paton and McLaughlin (2008) examine how the management of knowledge workers has a key role in knowledge transfer within the service sector. Blome et al. (2014) demonstrate how both internal and external knowledge transfer positively influence dyadic relationship flexibility. Khan et al. (2015a, 2015b) conduct a survey involving a sample of Pakistani local supply firms to analyse knowledge transfer from their international customers. The results show how formal mechanisms of socialization used by international customers improve the phase of knowledge transfer to local suppliers. In line with Khan et al. (2015a, 2015b), Kim et al. (2015) carry out a survey from the perspective of 137 small and medium supply firms to demonstrate how suppliers' relative absorptive capacity and their trust in customer influence positively knowledge transfer.

Hernandez-Espallardo et al. (2010) define the *managerial factors* as a set of company policies (incentives, socialization and control) that influence the process of knowledge sharing between the firm and other actors in dyadic relationship. Ke and Wei (2007) show that socio-political factors (trust towards the partner and the partner's power) affect a firm's decision on whether to share knowledge with partners or not. Cheung et al. (2010) analyse how environmental conditions (uncertainty and dissimilarity), inter-organizational properties (organizational fit, idiosyncratic investments), relationship learning and cultural distance are important factors affecting knowledge sharing between dyad members. Cheng (2011), in the green supply chain context, shows that relational risk affects the firm's willingness to share knowledge, and this association is negatively influenced by tangible relational value intangible relational value. Cheng et al. (2008) underline that trust has a significant influence on inter-organizational knowledge sharing. Luo et al. (2009) indicate that the relationship-specific investment of a company reduces opportunism and conflict as well as increasing knowledge sharing. Cheng and Fu (2013) suggest that a good practice to improve knowledge sharing in the dyadic relationship is to reinforce their relationship orientation and institutional orientation. Liu et al. (2015a) adopt the game theory to analyse the knowledge sharing in the dyadic relationship and identify the most important influencing factors (i.e. trust, knowledge protection, cultural differences, core enterprise). Liu

Table 7
Papers by process.

Process		References			
Knowledge management adoption		Bustinza et al. (2010) Liu et al. (2014) Loke et al. (2012) Mak and Ramaprasad (2003) Martin et al. (2008) Patil and Kant (2014a)			
		Patil and Kant (2014b) Patil and Kant (2014c) Reyes et al. (2015) Sudhindra et al. (2014) Zahay and Handfield (2004) ^a			
Knowledge management development	Knowledge creation	Breite and Koskinen (2014) De Vries and Brijder (2000) Dyer and Nobeoka (2000) ^a Esper et al. (2010) ^a Fletcher and Polychronakis (2007) ^a Fugate et al. (2012) ^a He et al. (2013) Hult et al. (2004) ^a Kanat and Atilgan (2014) ^a Li et al. (2011)			
		Malhotra et al. (2005) Malhotra et al. (2007) Raisinghani and Meade (2005) ^a Sambasivan et al. (2009) ^a Sangari et al. (2015) ^a Samuel et al. (2011) Tseng (2009) Tseng (2014) ^a Zahay and Handfield (2004) ^a			
		Knowledge storage	Hult et al. (2004) ^a Hult et al. (2006) ^a Kanat and Atilgan (2014) Nikabadi (2014a)		
			Raisinghani and Meade (2005) ^a Sangari et al. (2015) ^a Tseng (2014) ^a Zahay and Handfield (2004) ^a		
		Knowledge transfer	Blome et al. (2014) Desouza et al. (2003) Dyer and Nobeoka (2000) ^a Fugate et al. (2012) ^a Hernandez-Espallardo et al. (2010) ^a Kanat and Atilgan (2014) ^a Khan et al. (2015a) Khan et al. (2015b) Kim et al. (2012) Kim et al. (2015) Lee et al. (2009)		
			Lingegård and Lindahl (2015) Lu et al. (2014) Paton and McLaughlin (2008) Raisinghani and Meade (2005) ^a Rajendran and Rajagopal (2015) Sangari et al. (2015) ^a Schoenherr et al. (2014) Tatikonda and Stock (2003) Tseng (2014) ^a Zhang and Zhou (2013)		
			Knowledge sharing	Abid and Ali (2014) Al-Mutawah et al. (2009) Bernstein et al. (2015) Briscoe et al. (2001) Cantor et al. (2014) Chang et al. (2012) Chen et al. (2014) Cheng et al. (2008) Cheng (2011) Cheng and Fu (2013) Cheung and Myers (2008) Cheung et al. (2010) Douligeris and Tilipakis (2006) Dyer and Hatch (2006) Dyer and Nobeoka (2000) ^a Esper et al. (2010) ^a Fletcher and Polychronakis (2007) ^a Fugate et al. (2012) ^a Goel et al. (2005) Halley et al. (2010) Handfield et al. (2015) Hernandez-Espallardo et al. (2010) ^a	
				Huang and Lin (2010) Hult et al. (2004) ^a Ke and Wei (2007) Kovacs and Spens (2010) Lakshman and Parente (2008) Liu et al. (2012) Liu et al. (2015a) Liu et al. (2015b) Luo et al. (2009) Paulray et al. (2008) Pedroso and Nakano (2009) Raisinghani and Meade (2005) ^a Rollins et al. (2011) Sangari et al. (2015) ^a Saxena and Wadhwa (2009) Shih et al. (2012) Sivakumar and Roy (2004) Tseng (2014) ^a Wang et al. (2008) Wu (2001) Yang et al. (2009)	
				Knowledge application	Dyer and Nobeoka (2000) ^a Esper et al. (2010) ^a Hult et al. (2006) ^a Raisinghani and Meade (2005) ^a
					Sambasivan et al. (2009) ^a Sangari et al. (2015) ^a Tseng (2014) ^a

^a These papers deal with more than one phase of the process of knowledge management.

et al. (2015a, 2015b) develop a mathematical model to investigate how knowledge complementarity, knowledge integration capability, risk-averse degree and external uncertainty are factors affecting the incentive mechanism for knowledge sharing in an e-commerce service supply chain.

As for papers focusing on the supply network, one paper analyses the knowledge creation phase (He et al., 2013), two papers deals with the knowledge transfer phase (Desouza et al., 2003; Rajendran and Rajagopal, 2015), and two papers are concerned with the knowledge sharing phase (Chang et al., 2012; Cheung and Myers, 2008).

He et al. (2013) examine the hypothesis that the power of a

relationship measured by the availability of alternatives and moderation in its use may affect the creation of knowledge.

Desouza et al. (2003) indicate that different factors influence knowledge transfer in the supply network. The most important factors are knowledge acceptance behaviour, entropy and noise. Rajendran and Rajagopal (2015) conduct a multiple case study analysis to analyse knowledge sharing in the supply network. The results show how the risk associated by the firm to the knowledge transfer phase may be mitigated by an internalisation of previous knowledge.

Chang et al. (2012) analyse how relation-specific assets,

Table 8
Categorization of papers by topic area, phases of KM process and unit of analysis.^a

Topic area	Phases of KM process						Unit of analysis
	KM adoption			KM development			
	Knowledge creation	Knowledge storage	Knowledge transfer	Knowledge sharing	Knowledge application		
Factors affecting KM	5	3	1	9	10	Customer/supplier Supply network	
KMSs	1	1	2		2	Customer/supplier Supply network	
Barriers to the adoption of KM	3	1	1		3	Customer/supplier Supply network	
	2	2			6	Customer/supplier Supply network	
KM and performance		7	5	6	17	Customer/supplier Supply network	
		5	1	4	5	Customer/supplier Supply network	

^a Since some papers deal with more than one phase of the process of knowledge management, the total in table is 109 but the number of papers analysed is 82.

complementary resources and capabilities, knowledge sharing routines, and network position are the most important factors affecting firms at upstream downstream levels. Cheung and Myers (2008) classify different types of factors affecting the sustainability of a knowledge-sharing network into three categories: resource fit, management fit and market-related fit. These factors are relational capital, shared identity and flexibility.

In summary, the literature that focuses on this second area highlights a variety of factors that affect KM development; these factors may be classified into four main categories: *managerial factors* (equipment quality, production technology, service level, incentives, organizational fit, idiosyncratic investments, etc.); *relational factors* (cooperation, conflicts, partnerships, exchanging structured documents, contracts, joint project experience, inter-organizational trust, relationship-specific investment, etc.); *environmental factors* (technology uncertainty, product technology transfer effectiveness, uncertainty, dissimilarity, etc.); *socio-political factors* (socialization, the partner's power, opportunistic behaviour, institutional orientation, etc.).

Nevertheless, it does not consider *human and cultural factors*, such as human resources, people skill, motivation, training and education, and spirit of collaboration, that play a crucial role as stressed by Breite and Koskinen (2014); *technical factors*, such as degree of IT applications, information system, infrastructure, degree of KM adoption, and TQM practices; *firm specific factors*, such as international interactions, organizational proximity and organizational size.

This conclusion highlights the need to analyse these latter categories of factors (human and cultural, technical, firm specific) that affect the development of knowledge management in the supply network and in the dyadic relationship.

The content analysis of this area evidences two main gaps:

1. The first concerns the lack of papers regarding human, cultural, technical and firm-specific factors affecting knowledge management development, both in a dyadic relationship and in a supply network (second gap).
2. The second concerns the factors affecting knowledge storage and knowledge application, that are not analysed in either the dyadic relationship or the supply network (third gap).

Both of these gaps concern the process of knowledge development. Supply chain firms (customer, first and second tier suppliers) are subjects that learn. The factors that affect knowledge development generate learning modalities that in turn influence the firm's knowledge asset. This plays a crucial role in influencing the role of the various firms within the supply chain and then in determining the relationships among supply chain firms and the structure of the supply chain (Asanuma, 1989; Colombo, Mariotti, 1998). Thus, analysing these two gaps means not only addressing the factors affecting knowledge development, but also a more in depth investigation of the supply chain's operative mechanisms.

4.2.3. Knowledge management systems to support knowledge management adoption (Area 3)

The third area includes 3 papers focusing on knowledge management systems to support knowledge management adoption. In our approach, a KMS is an information system and/or a managerial practice adopted to support companies in creating, storing, transferring, sharing or applying knowledge (Corso et al., 2003).

The three papers included in this category concern the dyadic relationship. Specifically, Zahay and Handfield (2004) analyse how the top suppliers implement web-based tools to support knowledge management adoption. Authors underline that both technical capabilities and learning ability allow suppliers to automate their dyadic relationship processes using KMSs. Martin et al. (2008)

investigate the use of an e-commerce system and how the transition to the new knowledge management systems affects knowledge management adoption in a dyadic relationship. Reyes et al. (2015) conduct a survey on a sample of 300 supply chain professionals. The main findings show that the investments in radio frequency identification (RFID) allow firms to obtain benefits in the KM adoption process.

In summary, the papers that focus on this third area analyse how specific knowledge management tools (e.g. Ariba, E-commerce system, RFID) influence the process of knowledge management adoption. Nevertheless, they do not offer an exhaustive framework for the set of KMSs (tools and practices) that may support the knowledge management adoption phase.

Content analysis of “knowledge management systems to support knowledge management adoption” shows the need for an integrated approach to analyse a set of different tools and practices, implemented by individual companies to improve the efficiency and effectiveness of knowledge management adoption in a supply network and in a dyadic relationship.

In conclusion, the literature highlights the fact that the issue of knowledge management systems to support knowledge management adoption needs more extensive analysis, both in terms of the supply network and in a dyadic relationship (fourth gap).

This gap addresses an issue of great interest in management literature: the analysis of the degree of alignment between business strategies and the tools used (Henderson, Venkatraman, 1993; Chan and Reich, 2007). In the supply chain context, the issue of alignment between the nature of a firm's knowledge and the knowledge management systems (KMSs) used to support knowledge management is extremely relevant for three main reasons. Firstly, a correct alignment between the nature of knowledge and the KMSs used is itself a factor that could positively affect the KM process (vice versa it could also be a barrier to the KM process). Secondly, a misalignment between the nature of knowledge and KMSs generates problems of inefficiency (i.e.: underutilization of KMSs) and inefficacy (i.e.: use of unsuitable KMSs). Thirdly, over the last twenty years, the information and communications technologies (ICTs) have been offering new opportunities in terms of new knowledge management tools that are low cost, easy to use and an improved performance/price ratio (Garrigos-Simon, et al., 2012; Matlay and Westhead, 2005).

4.2.4. Knowledge management systems to support knowledge management development (Area 4)

The fourth area includes 12 papers focusing on knowledge management systems to support knowledge management development. Specifically, 5 papers deal with the dyadic relationship, and 8 papers focus on the supply network.

As far as the dyadic customer-supplier relationship is concerned, one paper addresses the knowledge creation phase (De Vries and Brijder, 2000), one paper focuses on the knowledge storage phase (Zahay and Handfield, 2004), and three papers deal with the knowledge sharing phase (Goel et al., 2005; Shih et al., 2012; Wu, 2001).

De Vries and Brijder (2000) examine the key role of information technology and show how it contributes to the process of knowledge creation.

Zahay and Handfield (2004) show how KMSs contribute to knowledge storage and underline the four information-processing capabilities: generation, memory, dissemination and interpretation.

Wu (2001) examines specific multi-agent systems (LivingFactory, DragonChain, StrategyFinder, eBAC) used by firms to improve the knowledge sharing phase. Goel et al. (2005) analyse how the use of multi-agent systems (Farm Smart 2000, Heifer Management System, Casa) and on-line auction applications (Agriculture.com,

Comdaq.net, Agex.com, Team.com, eBay.com) facilitate knowledge sharing and transparent economic transactions. Shih et al. (2012) highlight that the knowledge sharing process, when combined with adequate KMSs, could bridge the gaps between different partners with conflicting objectives.

As for the papers focusing on the supply network, two papers analyse the knowledge creation phase (Malhotra et al., 2005; Malhotra et al., 2007), and six papers focus on the knowledge sharing phase (Al-Mutawah et al., 2009; Bernstein et al., 2015; Douligeris and Tilipakis, 2006; Huang and Lin, 2010; Kovacs and Spens, 2010; Wang et al., 2008).

Malhotra et al. (2005) explore the nature and composition of a knowledge-management system analysing how collaboration between supply network partners can lead to new knowledge creation in the supply network, even when it may not be an explicit goal. Malhotra et al. (2007) describe how the use of standard electronic business interfaces (SEBIs) improve the flexibility of the supply network partnership and positively influence adaptive knowledge exchange process by enabling the collaborative information exchange between supply network partners.

Al-Mutawah et al. (2009) propose a multi-agent system (MAS) for tacit knowledge-sharing between manufacturing companies. Huang and Lin (2010) analyse how current technologies (EDI, RosettaNet, the current Web, etc.) are useful for sharing data or information rather than knowledge and underline that a category of technologies to improve the knowledge sharing process is the semantic web. Douligeris and Tilipakis (2006) present a framework of semantic ontologies for knowledge sharing in the supply network management sector. Kovacs and Spens (2010) examine different types of communities of practice (CoPs), as sharing techniques of organised and quality knowledge in the context of a relief supply network. Wang et al. (2008) develop a conceptual-based model (SCAPSM) for knowledge sharing in a supply network based on the technique of case-based reasoning (CBR). Bernstein et al. (2015) analyse the use of knowledge networks as a cooperative practice to model the process of knowledge sharing as a game among supply firms in order to reduce their fixed costs.

In summary, a content analysis of the papers of the fourth area highlights that the diverse contributions focus on specific tools or practices used by firms but no global overview or interpretative taxonomy emerges. Moreover some phases of knowledge management development (such as storage, transfer and application) are neglected, and there is no distinction between organizational practices and information tools. As for information tools, the body of literature does not investigate how data mining technologies (such as social data mining, data visualisation, text mining, crowdsourcing systems) and collaborative technologies (such as cloud computing, peer-to-peer resource sharing) belonging to Web 2.0 are used to improve the efficiency and effectiveness of the different phases of knowledge management development. This aspect is even more significant when considering the increasing importance of big data (Hazen et al., 2014; Waller and Fawcett, 2013) in supply chains and the rapid technological changes affecting the information and communication technologies that are providing new data mining and predictive analytics solutions.

The content analysis of this area shows two main gaps:

1. The first concerns how knowledge management systems to support knowledge management development need a more extensive analysis that highlights the whole set of tools and practices used by firms to improve the different phases in terms of efficiency and effectiveness (fifth gap).
2. The second concerns the lack of papers regarding the impact of big data and analytics on knowledge management in a supply chain (sixth gap).

The importance of contributing to overcome these gaps derives from two main reasons. The first is the same as the fourth gap and concerns the degree of alignment between supplier's knowledge strategies and the KMSs used. The second is strictly connected with the concept of the specific asset (Klein et al. 1978). The collaboration between customer and first-supplier and between first-tier supplier and second-tier supplier can induce firms to adopt the same KMSs that mean making specific (relational) investments. When this happens, one of the possible results is the reduction of production costs and/or a better quality of components, thus bringing about an increase in profit. This increase in profit is the relational quasi rent. Thus, addressing this gap means the identification of the set of tools and KM practices used, but also dealing with supply chain efficiency issues.

4.2.5. Barriers to the adoption of knowledge management (Area 5)

The fifth area, dealing with barriers to the adoption of knowledge management includes two papers by the same authors. Specifically, the papers included in this category focus on the supply network.

Patil and Kant (2014b, 2014c) identify 28 barriers divided into strategic, organizational, cultural, individual and technological. 50% of the obstacles for KM adoption in SC are due to these strategic barriers. Organizational barriers are also higher weighted, followed by cultural barriers. The “lack of management commitment” strategic barrier is considered the most important, and “KM not integrated with SC business process” is considered to be the second most important barrier, while “Lack of organizational structure to create and share knowledge” is the third barrier in the list. These barriers are identified in a literature review and by a focus group of experts comprising senior managers, IT representatives, KM project representatives, senior executives of SC members and customers. The individual companies perspective is not to be considered in the identification of barriers.

In summary, even though the authors analyse a set of specific barriers to the adoption of knowledge management (strategic, organizational, cultural, individual and technological barriers), they do not consider barriers such as financial, tacit or unformalised knowledge, the protection of critical information, the lack of time and resources, the lack of staff skill, the lack of confidence in the benefits, the lack of shared language, or integrations with existing processing and business culture, etc.

These two papers show the need for a systemic approach (that would include even the individual company point of view) to identify and analyse the whole set of barriers that influence the adoption of knowledge management in the supply network and in a dyadic relationship. In summary, this piece of literature highlights that the barriers to the adoption of knowledge management are not analysed in a dyadic relationship and are scarcely analysed in a supply network (seventh gap).

The analysis of the barriers hindering the adoption of knowledge management practices looks at three main issues. The first concerns the resistance to organizational change that is largely studied in literature (Piderit, 2000), but very much neglected in the field of supply chains (Johnson, 2010). The second regards customer and supplier behaviour. The identification of a set of barriers may help customers to coordinate the supply system as whole and suggest appropriate guidelines. Moreover, it may help suppliers to remove obstacles and gain positional advantages in the supply chain. Finally, it may help national and local government in the identification of policies to support the growth of increasingly crucial supply systems for the competitiveness of the new industrial systems.

4.2.6. Knowledge management development and performance (Area 6)

The sixth area dealing with the relationship between the knowledge management development process and performance

includes 31 papers (even though in Table 8, there are 56 papers rather than 31 in this area because some papers deal with more than one phase in the process). This is the most explored area. Specifically, 23 papers deal with the dyadic relationship and 8 papers focus on the supply network.

As for the dyadic customer-supplier relationship seven papers regard the knowledge-creation phase (Esper et al., 2010; Fletcher and Polychronakis, 2007; Hult et al., 2004; Raisinghani and Meade, 2005; Sambasivan et al., 2009; Sangari et al., 2015; Tseng, 2014), five papers concern the knowledge storage phase (Hult et al., 2004, 2006; Raisinghani and Meade, 2005; Sangari et al., 2015; Tseng, 2014), six papers focus on the knowledge transfer phase (Hernandez-Espallardo et al., 2010; Lingegård and Lindahl, 2015; Lu et al., 2014; Raisinghani and Meade, 2005; Sangari et al., 2015; Tseng, 2014), seventeen papers deal with the knowledge sharing phase (Abid and Ali, 2014; Cantor et al. 2014; Dyer and Hatch, 2006; Esper et al., 2010; Fletcher and Polychronakis, 2007; Handfield et al., 2015; Hult et al., 2004; Lakshman and Parente, 2008; Liu et al., 2012; Paulray et al., 2008; Pedroso and Nakano, 2009; Raisinghani and Meade, 2005; Rollins et al., 2011; Sangari et al., 2015; Sivakumar and Roy, 2004; Tseng, 2014; Yang et al., 2009), and six papers concern the knowledge application phase (Esper et al., 2010; Hult et al., 2006; Raisinghani and Meade, 2005; Sambasivan et al., 2009; Sangari et al., 2015; Tseng, 2014).

Esper et al. (2010) study how the creation of value for customers requires organisations able to strategically integrate the demand and supply processes through inter-organizational knowledge management. The authors also show that knowledge-sharing capabilities affect costs (inventory costs, transportation cost, lead times, and batch size), and the reduction of costs affects performance. Sambasivan et al. (2009) investigate the impact of knowledge creation and knowledge application on organization performance, focusing mainly on the first phase. A key component of knowledge creation is learning. The authors use the “supply chain learning” construct and its antecedents to encompass customer-supplier knowledge creation. Fletcher and Polychronakis (2007) demonstrate that knowledge sharing improves the richness of communications between customer and supplier. Consequently, performance measurement criteria are necessary to encourage partners to work towards shared goals. Hult et al. (2004) develop a model to link knowledge sharing to the reduction of cycle-time analysing strategic customer-supplier relationships.

Hult et al. (2006) indicate that the knowledge application phase is associated with dyadic performance from the point of view of four factors: speed, quality, cost and flexibility. Raisinghani and Meade (2005) investigate the linkage between knowledge management development and organization performance in terms of cost, time, flexibility and quality.

Lu et al. (2014) develop a model to analyse how knowledge transfer and compliance effort are two factors that impact on customer-supplier performance. Hernandez-Espallardo et al. (2010) explore how upstream knowledge transfer from customers to their suppliers can be governed. The authors investigate the effects of knowledge transfer on learning and performance in the empirical context of the apparel industry. Lingegård and Lindahl (2015) carry out a survey involving seven respondents from the customer's side and seven respondents from the supplier's side to show how knowledge transfer produces benefits in terms of reduced environmental impact and increased cost efficiency and quality.

Rollins et al. (2011) examine how knowledge sharing between logistics service provider and customer increases customer satisfaction and level of service. Abid and Ali (2014) describe how knowledge sharing has a positive impact for a market orientation strategy in order to achieve a competitive advantage. Dyer and Hatch (2006) consider “supplier knowledge management” as a key

factor in the achievement of a competitive advantage: companies that use the very same supplier network do not always obtain the same benefits. Lakshman and Parente (2008) show that knowledge sharing with the supplier (via face-to-face mode or web based tools), is a factor that leads to improved product and financial performances. Liu et al. (2012) investigate how distributive, interpersonal, informational and procedural justice impact on dyadic performance through the behaviour of both customer and supplier. Yang et al. (2009) analyse how information technology as well as an efficient knowledge of the sharing process with the supplier are key factors in improving performance. Sivakumar and Roy (2004) show that knowledge redundancy can be of value to a customer in order to improve the knowledge sharing phase and achieve a competitive advantage for both customer and supplier. Paulray et al. (2008) suggest that a tendency toward long-term relationships can increase collaboration between customers and suppliers, which is necessary for sharing strategically important knowledge for mutual gains. Pedroso and Nakano (2009) analyse how the three phases of the communications processes (pre-launch, product launch and continuous marketing) make an impact on the customer-supplier relationship in the pharmaceutical sector. Handfield et al. (2015) carried out a survey of 15 UK supply firms to show that the degree of alignment among supplier's knowledge capabilities improves supply chain performance.

Among the papers focusing on the supply network, five papers analyse the knowledge creation phase (Dyer and Nobeoka, 2000; Fugate et al., 2012; He et al., 2013; Kanat and Atilgan, 2014; Tseng, 2009), one paper focuses on the knowledge storage phase (Kanat and Atilgan, 2014), four papers deal with the knowledge transfer phase (Dyer and Nobeoka, 2000; Fugate et al., 2012; Kanat and Atilgan, 2014; Schoenherr et al., 2014), five papers address the knowledge sharing phase (Briscoe et al., 2001; Dyer and Nobeoka, 2000; Fugate et al., 2012; Halley et al., 2010; Saxena and Wadhwa, 2009), and one paper analyses the knowledge application phase (Dyer and Nobeoka, 2000).

Fugate et al. (2012) argue that an efficient process of creation, transfer and knowledge sharing is a key factor in acquiring competitive advantages on the global market. Authors also stress that knowledge management has a positive impact on the strategic and financial performance of a firm. Kanat and Altigan (2014) analyse how three phases of knowledge management (creation, storage and transfer) affect supply network productivity, the economy, profitability and efficiency. The authors highlight that knowledge creation is the factor with the most significant impact on supply network performance. He et al. (2013) show that there is a paucity of articles analysing how power among actors influences knowledge creation and in turn supply chain partner performance. The authors address this gap and find a positive relationship between knowledge creation and supply chain performance. Tseng (2009) proposes a conceptual model to investigate how firms exploit internal knowledge creation activities to gain external knowledge and obtain competitive advantages. This model also allows firms to analyse the knowledge creation process and evaluate the impact of customer, supplier, and competitor knowledge in the supply network. Dyer and Nobeoka (2000) analyse how knowledge resources affect company performance and show that some firm resources and capabilities are relationship-specific and not easily transferable to other customers or suppliers. Saxena and Wadhwa (2009) stress that knowledge sharing is very useful in creating value for a supply network. In this context, knowledge management can be used as an effective approach to achieve knowledge sharing among supply network partners. Briscoe et al. (2001) examine the competencies necessary for effective supply chain partnerships. A sample of SMEs are interviewed in order to determine if their emerging knowledge and skills are suited to

achieve supply chain integration. Halley et al. (2010) describe how the development of meta-competencies affecting knowledge sharing has an impact on supply network performance.

In summary, the literature highlights that the process of knowledge management can have a positive impact on a number of performances which can be classified into four major topics: *economic and financial performance* (profit, sales growth, cost reduction, etc.), *market performance* (market share, service quality, market flexibility, reputation, etc.), *technical performance* (innovation, growth in core competence, productivity, flexibility technical, etc.) and *organizational performance* (external partner and relationship, diffusion of new ideas, organizational agility, flexibility in resources utilization, etc.).

However, this literature does not consider human performance in terms of creativity, entrepreneurial growth, staff performance, staff satisfaction, etc. This is a very important factor, since knowledge development is strictly related to the human factor. From a content analysis of this area emerges the need to analyse in more detail the impact of knowledge management development on performance, considering the whole set of performances, including human performance that is not analysed in the literature, both in dyadic relationships and in supply networks (eight gap).

The issue of the relationships between knowledge management and a firm's performance has been extensively studied in the literature. Nevertheless, the supply chain is characterized by a number of relationships between customer and supplier, and these are usually small and medium supply firms. In this context, the analysis of the relationships between knowledge management and a firm's performance in the field of the supply chain cannot fail to consider the impact of knowledge management on either relational performance (customer/first-tier supplier and first-tier supplier/second-tier supplier) and human performance. Neglecting these two issues means to underestimate the advantage of KM adoption practices. In practice, the literature on the relationship between KM and performance in the field of supply chains is influenced by the literature that focuses on the reality of the large company and neglects human and relational issues (Martin et al., 2006; Marra et al., 2012). Overcoming this gap may help to understand all the possible advantages for the supplier and the supply chain.

5. Conclusions and implications

This paper has conducted a systematic review of the literature on the topic of knowledge management in the supply chain and is complementary to, but does not substitute, two previous reviews by Martin et al. (2006) and Marra et al. (2012). Whereas Martin et al. show the extend to which KM supports sustainable competitive advantages and Marra et al. highlight the processes of knowledge exploitation and exploration, this paper considers three perspectives: the unit of analysis (the dyadic relationship, the supply network), the phases of the KM process (adoption, creation, storage, transfer, sharing, and application), and the topic area (factors affecting KM, KMSs, barriers to the adoption of KM, and KM and performance). The results that emerge are added to those of the two previous reviews and confirm the opportunity to propose a further review.

The descriptive analysis offers an overview of the papers included in the literature review. This has made it possible to provide a summary view of the papers on the topic of knowledge management in the supply chain context. In particular, the descriptive analysis has highlighted that knowledge management along the supply chain is a crossroads research area that involves a variety of journals focusing on different subject areas. The descriptive analysis has not only confirmed that knowledge

management in a supply chain is a topic still neglected in literature, but has highlighted that it is overlooked even by journals of supply management and journals of knowledge management. The vast majority of papers are based on quantitative methodologies, with few papers using qualitative or conceptual approaches. Moreover, there is a prevalence of papers dealing with the dyadic customer-supplier relationship compared with those focusing on supply network analysis. Regarding the topic area, descriptive analysis has made it possible to identify four topic areas: factors affecting KM, knowledge management systems, barriers to the adoption of KM, and KM and performance. The topic area most analysed is that of “knowledge management and performance”, whereas “barriers to the introduction of knowledge management” is a relatively unexplored topic area. Concerning the process of knowledge management, descriptive analysis shows that there are only few papers focusing on “knowledge management adoption”, “knowledge storage”, and “knowledge application”, but there are a variety of papers on the topic of “knowledge sharing”.

The content analysis of the papers included in the literature review has given us an overview of the main issues covered by research on knowledge management in the supply chain context. Specifically, content analysis of the papers has highlighted six areas of investigation: factors affecting knowledge management adoption; factors affecting knowledge management development; knowledge management systems to support knowledge management adoption; knowledge management systems to support knowledge management development; barriers to the adoption of knowledge management; and knowledge management development and performance. From these six areas of investigation, eight main gaps in the literature are emerged. These gaps represent nine research questions to be investigated.

From the first area emerges the need for a more comprehensive analysis of the factors affecting the adoption of knowledge management practices both in a dyadic relationship and in a supply network (first gap). Starting from this gap it is possible to formulate the first research question:

RQ1: What are the factors affecting knowledge management adoption?

The content analysis of the papers dealing with the factors affecting knowledge management development has made it possible to highlight the lack of papers concerning human, cultural, technical and firm specific factors affecting knowledge management development, both in the dyadic relationship and in a supply network (second gap). Moreover, there is also a lack of papers regarding factors affecting knowledge storage and knowledge application both in dyadic relationship and in a supply network (third gap). These two gaps allow us to identify the following research questions:

RQ2: What are the factors affecting knowledge management development?

RQ3: How do human, cultural, technical and firm specific factors affect knowledge management development?

The third area of investigation (Knowledge management systems to support knowledge management adoption) has highlighted that the issue of knowledge management systems to support knowledge management adoption needs a more extensive analysis, both for the supply network and the dyadic relationship (fourth gap). The relevant research questions are:

RQ4: How do KMSs support knowledge management adoption?

RQ5: What is the degree of alignment between KMSs used by suppliers and the nature of knowledge from the ontological and epistemological perspectives?

From the content analysis of the fourth area (Knowledge management systems to support knowledge management development) it emerges that knowledge management systems to support knowledge management development need a more extensive analysis that highlights the whole set of tools and practices used by firms to improve the different phases in terms of efficiency and effectiveness (fifth gap). Moreover, there is a *lack of papers on the impact of big data and analytics on knowledge management in the supply chain* (sixth gap). This gap allows us to identify the following two research questions:

RQ6: Which are the main tools and practices used by firms to improve the different phases of the process of knowledge management development?

RQ7: How do big data and analytics impact on knowledge management in the supply chain?

The content analysis in the fifth area (Barriers to the adoption of knowledge management) has revealed that the barriers to the adoption of knowledge management are not analysed in a dyadic relationship and are scarcely analysed in supply networks (seventh gap). From this gap the following research question may be formulated:

RQ8: What are the barriers to the adoption of knowledge management?

Analysis of the sixth area (knowledge management development and performance) has pointed out the need to analyse in greater detail the impact of knowledge management development on performance, considering the whole set of performances including human performance, which is not analysed in literature, in both dyadic relationships and supply networks (eight gap). The research question is:

RQ9: What is the relationship between knowledge management and firm performance?

These research questions represent some possible areas of investigation to improve the body of knowledge in the field of knowledge management in the supply chain context. These areas of investigation need to be analysed taking into consideration not only the dyadic customer-supplier relationship, but also the supplier-supplier relationship within the supply network.

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