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Research Note

Knowledge management and ERP: Complementary or contradictory?

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ABSTRACT

This research aims at deepening the understanding of the effects of information systems on supply chain operations, and to find the level and direction of the relationship between Enterprise Resource Planning (ERP) and Knowledge Management (KM) in the context of operational and financial performance. Essentially, this study emphasizes the explanation of the complementary relationship between ERP and KM. Therefore, the mediating effect of KM is also analyzed. Using a survey method, 163 responses are collected from Turkish manufacturing companies which operate in a variety of industries. A structural equation modelling (SEM) is used to test both the reliability and validity of measurement and the structural path model. The results show that ERP has no significantly positive effect on operational performance, but it is a precedent of KM. Moreover, results also show that KM affects operational performance positively and it has a mediating effect for the relationship between ERP and operational performance. Lastly, the path analysis shows that operational performance is positively associated with financial performance.

1. Introduction

In this era of stiff global competition, knowledge/know-how is widely recognized as one of the core assets/enablers for any organization, service or manufacturing (Davenport and Prusak, 1998; Drucker, 1993). The ability of organizations to identify, codify and leverage/use of their knowledge sources have become a significant determinant of their competitive posture (Bhatt, 2001). Therefore, the field of knowledge management has emerged as a fruitful research area of interest to both academicians and practitioners (Wiig, 2000). There seem to be a consensus amongst the educational as well as practitioner community that effective implementation and proper management of knowledge management are essential to compete in the highly dynamic global business environment (Delen, Zaim, Kuzey, & Zaim, 2013; Hicks, Dattero, & Galup, 2007; Zaim, 2006).

Today's organizations, often viewed as an extended enterprise that include suppliers and vendors (upstream) and customers and distributors (downstream), are usually arranged in processes that handle both goods/services and information that we nowadays collectively call as the supply chain. The management of such processes are called supply chain management, or SCM in short (Su & Yang, 2010). Supply chain has been one of the most popular investigative topics for both managers/practitioners and researcher/academicians in recent years, and many firms have gained competitive advantage by carefully researching and properly improving their supply chain capabilities. In the extant literature, supply chain management is covered rather wide and technically deep, including research that aimed at addressing issues like optimal selection of suppliers, improving collaboration among supply chain members, better management of warehouses, balancing risk and reward shared between buyers and sellers, handling logistics of hazardous material, improving vehicle routing, enabling green supply chain, to name just a few. What makes supply chain research challenging and potentially more impactful is to study it within the context of knowledge management.

Knowledge management (KM) is a relatively new concept for organizations, and it has been recognized as a mission-critical task, and hence, covered as a worthy research topic by both academics and practitioners (i.e., service/good providers and consultancy companies). Knowledge (especially tacit knowledge) can be viewed as a source of soft power that provides competitive advantage to organizations.

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Know-how, a common manifestation of knowledge, plays an important role in obtaining and sustaining a competitive posture (Chatzoudes, Chatzoglou, & Vraimaki, 2015). KM is known to provide the means necessary to explicate, codify and maintain critical know-how in an organizational environment. Creation, codification and storage of knowledge can be perceived as separate, consecutive and mostly recursive sub-processes by which organizational knowledge can be managed (Geisler & Wickramasinghe, 2015). Although the value proposition of KM is obvious, many organizations struggle with defining, acquiring and managing knowledge that resides within them.

KM is a multidisciplinary concept that can be described and analyzed from different perspectives (Geisler, 2007). From the resource-based view, knowledge is regarded as a vital organizational resource, which is rare, valuable, and difficult to imitate (Greiner, Böhmann, & Krcmar, 2007). However, harnessing knowledge resources effectively and efficiently requires an integrated approach which combines KM with several other management tools and systems including SCM and enterprise resource planning (ERP) (Jasimuddin, 2008). It has been suggested that from a holistic perspective, ERP-enabled SCM can contribute to KM outcomes and KM can be considered as an antecedent to ERP success (Sedera, Gable, & Chan, 2003).

ERP is a crucial information system/technology tool for corporations to manage their supply chain processes by means of identifying, capturing, integrating and storing the flow of data/information created by means of executing their business transactions, with both entities inside and outside of the firm. Essentially, to achieve integration and coordination among departments within the firm as well as vendors and contractors outside the firm, ERP provides the capabilities to control and manage both material and information flows (Migdadi & Abu Zaid, 2016). ERP systems consists of several different modules including, supply chain, manufacturing, warehouse management, and quality. Despite its relatively high cost of acquisition and implementation, many organizations (small, medium, large in size) have implemented ERP solutions to better manage their processes. From the perspective of resource-based view (RBV), combining both tangible and intangible resources expected to result in better outcomes than using a single resource type view. In their study, Hult, Ketchen, Adams, and Mena (2008) asserted that combining all aforementioned resources (SCM, KM, ERP) have a stronger effect on business performance than simply the direct effect of each resource individually.

In this study, two key resources are considered simultaneously and synergistically: software packages related to ERP systems and knowledge management practices. The opinion, where the question is whether there is a positive synergy between ERP and knowledge management, is discussed in this research paper, especially with regards to its implication on supply chain performance. This study fills an important gap in the literature by integrating the effects of knowledge management and ERP on business performance using an empirical research method.

2. Literature review and hypotheses development

This part of the manuscript is organized in four sub-sections; the first three (related to KM, ERP and RBV) provides the most relevant literature pertaining to the present study while the fourth sub-section provides the development of the hypotheses tested within the context of this study.

2.1. Knowledge management (KM)

Knowledge has been one of the most popular debate topics in business philosophy for a very long time (Alavi & Leidner, 2001). In the current face of global competition, manufacturing as well as service firms must improve their core competencies by constantly learning and adapting to rapidly changing business environment/condition. Knowledge management is often perceived and proposed as a key enabler for building such a competency (Wang, Klein, & Jiang, 2007). Generaly speaking, knowledge can be defined as '*information plus the causal links that help to make sense of this information'* and knowledge management can be defined as'*a process that establishes and clearly articulates such links*' (McGinnis & Huang, 2007; Sarvary, 1999). Also Alavi and Leidner (2001) defined knowledge as "*information possessed in the mind of individuals: it is personalized information (which may or may not be new, unique, useful or accurate) related to facts, procedures, concepts, interpretations, ideas, observations and judgments"*. A knowledge-based perspective has been widely discussed in the strategic management literature. It refers to how services offered by tangible resources can transform to a function of the organization's know-how (Alavi & Leidner, 2001; Hung, Tsai, Lee, & Chau, 2015).

The knowledge is usually buried within the organizational structure, and transferred through a combination of ways/assets such as organizational culture, policies and procedures, and mentorship of employees (Grant, 1996a, 1996b). The major competitive advantage for a firm lies within the organizational knowledge assets and therefore 'knowledge management' has Become a highly critical issue. Knowledge management has now been largely established as a competitive strategy that can provide many advantages to a company. One of the advantages of KM in manufacturing or service organizations is employee training. Proper and timely training in both the short- and long-term can have positive effects on the performance of a company. Knowledge retained in a "server" allows access to critical information at all levels of an organization, and provides a vehicle for people to improve themselves in both formal and informal ways. It can potentially reduce the amount of structure required by eliminating excuses and depoliticize the organization, thereby empowering people to learn on their own time and pace (Gunasekaran & Ngai, 2007).

Knowledge-based resources, especially the one in tacit form, are difficult to copy and it can be different from organization to organization. Therefore, such a unique set of knowledge assets may provide competitive advantage in the long term. Information can be seen as processed data and in that case knowledge would be authenticated information. Text, graphics, words are different ways of knowledge representation, and these explicit representations can provide a common language and some understanding of actionable information (aggregated, conceptualized data) for all stake holders (Alavi & Leidner, 2001; Zaim, 2005). Knowledge can be conceptualized and analyzed in different ways; a state of mind, an object, a process, a condition of having access to information, and acquisition of a capability.

There are two dichotomous versions of knowledge in literature: tacit and explicit. Tacit knowledge is embedded in action and experience. It covers cognitive and technical elements (Nonaka and Takeuchi, 1995). The cognitive one refers to a person's mental models and includes beliefs and viewpoints; the technical one covers know-how, skills and ingenuity. Explicit knowledge refers to the codified and formed knowledge with symbolic or natural language. There are also other knowledge types in the literature: declarative (know-about), causal (know-why), conditional (know-when) and relational (know-with) (Alavi & Leidner, 2001; Norton, 1998; Zack, 1998).

Generally, KM said to have three main goals: (1) making knowledge clear and stating the importance of it in a firm, (2) establishing a knowledge-intensive culture with stimulating behaviors like knowledge sharing, (3) establishing a knowledge infrastructure, both of technical (e.g., e-mail system, servers etc.) and social (e.g., collaborating, meeting, exchanging) ones (Alavi and Leidner, 2001). In the KM related literature, researchers have indentified three types of learning: individual, with communication, and utilizing a knowledge repository (Heijst, Spek, & Kruizinga, 1997; Liao, 2003). Accordingly, KM performance may be evaluated at three levels/stages: strategic level, functional/operational level and employee/performer level. The first level relates to the contribution of knowledge management activities to organizational performance. The functional/operational performance measures the effect of knowledge management processes on operations

of organizations such as; production, delivery and forecasting of demand. The last one evaluates the support of knowledge management processes on employees' behaviors or job satisfactions (del-Rey-Chamorro, Roy, Wegen, & Steele, 2003; Zaim, 2005).

To improve organizational capabilities that rely on knowledge, firms can design, develop and apply knowledge management processes. Since knowledge is a valuable and intangible resource/asset to the organizations (Hult, Cavusgil, & Calantone, 2006), it can also be viewed as an important factor to properly manage supply chain operations. There is very little research, which has investigated the relationship between knowledge management and supply chain performance (Hult et al., 2006). There are three theoretical approaches that help analyze the impact of knowledge management on business performance: the resource based view (RBV), strategic choice theory, and configurational inquiry. According to the resource-based view, knowledge elements that add value to the supply chain should be determined. Strategic choice theory points out why these types of knowledge elements are important for different supply chain strategies, including prospectors, analyzers, low cost defenders, differentiated defenders and reactors. Configurational inquiry investigates the relationship between supply chain knowledge and business performance.

As mentioned above, RBV is based on refining knowledge elements that can affect business performance (Barney, 1991; Wernerfelt, 1984). To be a strategic resource, knowledge must satisfy some basic constraints (Barney, 1991). First of all, the knowledge must be valuable, meaning that it influences the generation of outputs that meet customers' needs. Secondly, knowledge must be rare, meaning that the resource is not regularly available. Lastly, knowledge must be inimitable, which refers to the fact that obtaining the resource is hard. Knowledge is an intangible resource, which can not be moved or bought readily, since it is embedded in the structure of an organization (Barney, 1991; Grant, 1996a, 1996b).

According to Hult (2006), there are eight different elements of knowledge management: memory, tacitness, accessibility, quality, use, intensity, responsiveness and learning capacity. Memory is the level of obtained knowledge and experience related to organizational activities (Moorman & Miner, 1997). Tacitness refers to the level of codifiability and teachability of knowledge (Simonin, 1999; Zander & Kogut, 1995). Accessibility points out the degree of reachability of the source (Hult et al., 2006). Quality refers to relevance, accuracy, and reliability of knowledge (Low & Mohr, 2001). Knowledge use means the application of knowledge for solving problems and making decisions (Deshpande & Zaltman, 1982). Knowledge intensity can be defined as '*the extent to which a firm depends on the credible… information and/or experience inherent in its operations as a source of competitive advantage*' (Craighead, Hult, & Ketchen, 2009). Responsiveness refers to actions that are sourced from knowledge and learning capacity, and is defined '*as the extent to which a chain continuously builds its usable knowledge to develop a foundation for its competitive edge*' (Hult et al., 2006).

2.2. Enterprise resource planning (ERP)

A wide variety of ERP software packages are used by companies in different sectors. ERP is the successor of Material Requirement Planning (MRP) (from the 1970s) and Material Requirement Planning II (MRP II) (from the 1980s). It is commonly used because of the constant requests that firms receive from their suppliers and/or distributors in their extended supply chain so as to provide them with intersystem linkages (Su and Yang, 2010). Su and Yang (2010) defined ERP as *'an integrated enterprise computing system that is designed to automate the flow of material, information, and financial resources among all functions within an enterprise on a common database.'* Lee and Lee (2000), on the other hand, identified ERP as an enterprise-wide package that combines business processes into a single shared database. Shanks and Seddon (2000) (cited by Newell, Huang, Galliers, & Pan, 2003) also described ERP as an exhaustive software package that integrates the business functions by using a shared information flow. Akkermans, Bogerd, Yucesan, and van Wassenhove (2003) pointed out that ERP has been used to integrate the different operations in a business organization; however in today's SCM, networks of suppliers and customers are more important than in the past and the old type of ERP packages are inadequate in the current market economy.

There are many ERP solution providers in the market, some of them are expensive with a lot of different modules, and some of them are cheaper and focus only on special operations such as accounting or production planning. Furthermore, regardless of its features and coverage, ERP software cannot fully meet the needs and expectations of a given company, largely because every company runs its business with different practices, strategies and goals. That is, ERP vendors use different hardware platforms, databases, and operation systems. Thus, companies should conduct apriori requirements analysis to make sure that the selected ERP system suits their requirements at the highest level possible. However, ERP implementation is not easy. The literature shows that nearly 90 percent of ERP projects were completed late and/or exceed pre-determined budget limits (Ayağ & Özdemir, 2007; Holland & Light, 1999).

Despite its many benefits, and all the good intentions, sometimes ERP implementations fail. In fact, recent history shows that a third of all ERP implementations were terminated before successful completion. Therefore, sourcing of ERP solutions is one of the most important success factors. Relatedly, there seem to be two different ways to get/acquire ERP: standard or custom built. The standard package requires very little if any significant customization. That is, the corporate process adopts to the ERP software as opposed to having ERP software adapt to a firm's specific processes. According to Holland and Light (1999), there are several critical success factors for ERP implementation, some of them are at the strategic level and others are at tactical level. Legacy systems, business vision, ERP strategy, top management support and project schedule are among the strategic factors, while client consultation, personnel, software configuration, client acceptance, monitoring/feedback, communication and trouble shooting are among the tactical factors (Benjamin & Levinson, 1993; Grover, Seung Ryul, & Teng, 1998; Holland & Light, 1999; Kotter, 1995; Slevin & Pinto, 1987).

Before ERP, many large-scale global firms were faced with difficulties in their operations such as integration of business processes. According to Newell et al. (2003), ERP provides a competitive advantage because crucial information is produced, shared, and managed in an integrated manner. ERP usage ensures the reduction of costs, advancement of resource controls, and improvement of decision quality, or, in other words, leaner more streamlined business operations (Communications of the ACM, 2000; cited by Newell et al., 2003). Some of the previous research has also shown that investment in information technologies, such as ERP systems, helps to enhance/ensure a firm's competitive posture (Kathuria, Anandarajan, & Igbaria, 1999).

In contrast to its positive effects, ERP implementation may also cause problems. The dream of successful ERP implementation can sometimes turn into a nightmare if executives and managers are not fully committed to the project. One of the problems with ERP systems is to keep it up to date. That is, maintenance and updating of the software is often costly, time demanding and destructive. There are also indirect costs of having an ERP system that does not fit well—incompatible to the existing business processes and systems among departments, as opposed to integrating—may increase the disjoint nature of the interdepartmental relationships (Davenport, 1998). This problem can be mitigated with a carefully designed and executed implementation process, where departmental needs and requirements are carefully prioritized and implemented.

2.3. Supply chain management (SCM)

Supply chain management is a very popular concept in today's

business environment. Sometimes, a supply chain may be viewed/perceived as referring to only logistics activities, but such a view understates the comprehensiveness and importance of the concept. All processes, from buying of raw materials to after-sale customer services, are elements of the supply chain. According to some (Becthel and Jayanth, 1997; Min, 2001), supply chain includes all of the firm functions such as: logistics, manufacturing, purchasing, marketing, promotion, sales, R & D and product design.

There are several definitions of supply chain. For instance, Mentzer et al. (2001) defined supply chain as '*a set of three or more organizations directly linked by one or more of the upstream and downstream flows of products, services, finances, and information from a source to customer*.' On the other hand, Su and Yang (2010) defined supply chain as '*the network of facilities and activities that performs the functions of development, procurement of material from vendors, the movement of materials between facilities, the manufacturing of products, the distribution of finished goods to customers, and after-market support for sustainability*.' The organization and arrangement of the Supply Chain Management (SCM) concept includes following characteristics (Mentzer, 2001, cited by Min & Mentzer, 2004):

a) 'a systems approach to viewing the supply chain as a whole, and to managing the total flow of goods from the supplier to the ultimate customer,
b) a strategic orientation toward cooperative efforts to synchronize and converge intra-firm and inter-firm operational and strategic capabilities into a unified whole, and
c) a customer focus to create unique and individualized sources of customer value, leading to customer satisfaction'.

The classical concept of supply chain management (SCM) (i.e., functional integration) has expanded in recent years, and the importance of cooperation and integration among supply chain members is further emphasized to improve competitiveness of the extended supply chain (Min & Mentzer, 2004). To satisfy the SCM activities (e.g., efficient consumer response, quick response, forecasting and replenishment) efficiently, collaborative activities such as joint forecasting and planning, information sharing, joint inventory management were among the proposed metrics (Min & Mentzer, 2004). Additionally, some authors (e.g., Cooper & Ellram, 1993; Min & Mentzer, 2004) emphasized several key elements of successful SCM, which included information sharing, cooperation, long term relationships, mutual risk and reward sharing. Christopher (1992) suggested that the real competition amongst the corporates should be characterized as supply chain against supply chain, rather than a single company against another company.

2.4. Resource based view (RBV)

According to the resource based view (RBV), a company should develop, acquire, and use its strategic resources to become one of the best performing firms in the marketplace (Barney, 1991; Wernerfelt, 1984), and corporations can gain competitive advantage by using their resources effectively (Chae, Olson, & Sheu, 2014). Resource management can be defined as "*the comprehensive process of structuring the firm's resource portfolio, bundling the resources to build capabilities, and leveraging those capabilities with the purpose of creating and maintaining value for customers and owners*" (Yang, 2012). Resources can be classified as tangible and intangible ones. Tangible resources are physical items and they can be transferred inside a firm, while intangible resources are tacit and hence very difficult to copy and transfer (Hult et al., 2008; Kogut & Zander, 1992; Villalonga, 2004). Because intangible resources generally can not be transferred easily, they are the critical elements on which to build competitive advantage against rivals/competitors (Itami & Roehl, 1991; Villalonga, 2004).

The RBV theory proposes that a resource, which is both valuable and rare, can supply a unique competitive advantage (Sirmon, Gove, & Hitt, 2008). Human capital is one of the most important intangible resources (Miller & Shamsie, 1996) and it can be encapsulated/described as the skills, experiences and knowledge that employees possess (Becker, 1964; Sirmon et al., 2008). Additionally, according to Yang (2012), capabilities can be classified as exploration and exploitation. Exploration is the "*experimentation with new alternatives having returns that are uncertain, distant, and often negative*" and exploitation is "*the refinement and extension of existing competencies, technologies, and paradigms exhibiting returns that are positive, proximate and predictable*" (Marter, 1991; Yang, 2012).

Tangible resources are usually defined as financial and physical assets, while intangible resources are technology, accumulated consumer information, brand name, reputation and corporate culture (Itami & Roehl, 1991; Villalonga, 2004). For value add, organizations must collect, integrate and exploit these resources (Sirmon & Hitt, 2003; Yang, 2012). However, in the literature there is a lack of coverage between management of resources and the value added (Yang, 2012). There are four characteristics of resources: valuable, rare, imperfectly imitable, imperfectly mobile; not substitutable (Barney, 1991). Furthermore, RBV is concerned with resource bundling (Hult et al., 2008), meaning that by integrating both tangible and intangible resources rather than focusing on a single resource, organizations can obtain greater benefits in a competitive marketplace. The other definition refers to the integration of resources of firms to form new capabilities (Yang, 2012). So in this research, it is expected that for supply chain-oriented firms, ERP and KM will have stronger positive effects on performance than those firms that do not utilize ERM and KM (Jayawickrama, Liu, & Smith, 2016). Additionally, the impact of ERP on financial performance is expected to be the strongest when supply chain oriented firms apply KM processes.

Resource bundling can offer lower cost, higher utilization, and, hence, competitive advantage. The bundles can provide feedback, monitoring and regulating policies, and furthermore, they can be control mechanisms of strategies for managers (Rootner, 2009). Particular combinations can provide distinctive capabilities for organizations; therefore, experimenting with different bundles can potentially bring incremental and significant positive change (Prahalad & Hamel, 1994). Because the control levels of many companies on different resources vary, they can combine and/or integrate their resources according to their expectations for common use and, hence, higher utilization. This may lead to differentiated services and/or products, agility and customer orientation, and therefore, enhancement of their competitive position (Wernerfelt, 1984; Rungtusanatham, 2003).

2.5. Hypotheses development

In the literature, a wide variety of benefits of ERP implementation are identified and discussed, such as providing means for faster transactions, reducing cycle time, allowing better cost accounting and financial management, and helping make tacit knowledge accessible (Su and Yang, 2010). Davenport (1998) emphasized the different outcomes of ERP implementation, such as reduced cycle time, improving information flow and rapid formation of financial information. According to Holland and Light (1999), ERP facilitates greater managerial control, rapid decision making, and reduction of operational costs. Furthermore, in the research of Su and Yang (2010) and Maas, van Fenema, and Soeters (2016) a positive relationship between ERP, supply chain management competences and innovation was shown. So, the notion that the direct effect of ERP on operational performance is positive is supported.

Within the context of a well-designed empirical research study, Cotteleer and Bendoly (2006) proposed and argued about two related hypotheses. First, they discussed whether the implementation of enterprise systems like ERP will positively affect the operational performance in the short term. In addition, they also claimed that after the

deployment of enterprise systems, firms may obtain new knowledge, and, therefore, operational performance would be improved. In their study, they investigated the situation of Tristen Corporation, which is a US-based company and producer of equipment for computers and servers, comparing its performance within the framework of pre- and post-ERP adaptation. Tristen has three production areas around the world including America, Europe, and Asia. In this study, the authors showed that the aforementioned hypotheses are supported after the implementation of ERP.

In another related study, Bendoly and Schoenherr (2005) showed that ERP usage decreased material procurement costs, because it enhanced the information and decisions needed for advanced material requirements, advanced production planning, identification and reduction of bottlenecks and waste in the production process. With a case study, McAfee (2002) have also shown that the effects of ERP usage on performance is rather significant. In this case-study type research effort, a huge company was studied to observe the consequences of ERP. According to the results/analyses, average lead time and late shipments decreased significantly after the ERP implementation and usage. However, some performance criteria were improved only in the long run, presumably requiring a rather lengthy time period to mature and make an impact on the process metrics. In addition, the study by McAfee (2002) proposed that most employees in an organization believe that the performance level achieved could not be reached without the use of ERP.

H1. ERP Usage is positively related to operational performance.

As noted earlier, very few research studies have investigated the relationship between knowledge management and supply chain performance. Hult et al. (2006), Barney (1991), Wernerfelt (1984), and Grant (1996a, 1996b) showed that there is a positive relationship between Knowledge Management and performance. Similarly, Fugate, Stank, and Mentzer (2009) investigated the relationship between Knowledge Management and organizational performance. They considered knowledge generation, knowledge dissemination, knowledge interpretation and knowledge responsiveness. This research again showed the positive impact of Knowledge Management on performance in the context of logistics operations.

According to Craighead et al. (2009), "what we know" and "what we need to know" to improve supply chain performance are the most basic questions for research. In their study, hypotheses related to knowledge management were tested for different strategy types. They showed that knowledge management had a positive impact on performance for three different strategic types: costly efficient imitators, costly imitators and costly innovators. Cost efficient imitators refer to better than average cost efficiencies and a preference to imitate competitors' successful practices rather than to innovate. Cost imitators' costs are usually higher than their competitors. Also, costly innovators innovate and the cost of innovation is higher than that of imitation. Additionally, Blumenberg, Wagner, and Beimborn (2009) emphasized a positive relationship between knowledge transfer and outsourcing performance. Terms of trainings, strategic level agreements and standards are discussed in this research. Sivakumar and Roy (2004) studied about knowledge redundancy and supply chain performance. Knowledge redundancy "*conjures up images of duplication and waste created in the pursuit and mastery of knowledge by intra or inter firm team members*" (Sivakumar and Roy, 2004). Therefore, that the direct effect of Knowledge Management on operational performance is positive is supported.

H2. Knowledge Management (KM) is positively related with operational performance.

In today's competitive business environment, SMEs need to *"integrate and optimize internal business processes in order to minimize costs, improve the quality of products and services, and increase customer satisfaction, exploit and use appropriate and up-to-date knowledge in order to compete and gain competitive advantage; and avoid knowledge loss in order to retain competitiveness"* (Metaxiotis, 2009). Therefore, properly combining ERP and KM is required for SMEs. ERP can increase the operational efficiency by providing connections within different parts in the company so managers and workers use less time for one unit production. Meanwhile, the organizations can gain competitive advantage with KM in order to compete their rivals (Metaxiotis, 2009).

Newell et al. (2003) investigated these two subjects to answer the question of "can ERP and KM be applied in tandem and is there a complementarity between ERP and KM possible?" Both, ERP and KM are applied together in many organizations (Alavi and Leidner, 2001). According to Newell et al. (2003), ERP satisfies competitive advantage through crucial information, which is produced, shared, and managed. Reducing costs, advancing resource control and decision quality, or in other words, producing leaner production processes can be seen as the advantages of ERP (Newell et al., 2003). KM emphasizes how an organization can improve competitive advantage with more effective usage of its knowledge resource. There is, however, a difference between ERP and KM in their orientation: KM systems focus on flexibility and innovation, whereas ERP on efficiency and the dilemma between efficiency and flexibility/innovation is a popular discussion topic in organizational theory (Newell et al., 2003). They suggested that usage of ERP and KM attempts together produces a complementary rather than conflicting outcome, as a result, enabling flexibility and efficiency simultaneously. This research studies the application of KM and ERP at the same time.

In a related study, Sedera and Gable (2010) explored the relationship between KM competence and ERP and it was suggested that there is a positive and significant relationship between KM competence and ERP success. In this research, factors of ERP's that were considered include system quality, information quality, individual impact and organization impact. Meanwhile, those associated with KM competence include knowledge creation, knowledge retention, knowledge transfer and knowledge application. Furthermore, Xu, Wang, Luo, and Shi (2006) have also investigated the relationship between ERP and KM. According to their study, RP provides an infrastructure for KM to discover, classify and store knowledge. Parry and Graves (2008) pointed out the relationship between ERP and KM, and their research reinforced that ERP is useful to capture and codify knowledge. However, to transfer tacit knowledge to explicit knowledge, other knowledge sharing techniques such as discussion groups and expert meetings are needed.

H3. ERP Usage is positively related with Knowledge Management (KM)

H4. Impact of ERP Usage on operational performance mediated by KM is stronger than the its direct effect.

Last but not the least, it is hypothesized that there is a direct relationship between operational performance and financial performance because operational performance refers to the efficiency of the activities performed within the firm. These efficiencies include reduced cycle time, fast response to customers, delivery on time, increased customer satisfaction, and hence, increased sales and revenue. In addition to these, some operational performance criteria such as, lower inventory levels and forecasting accuracy can also be attributed to cost reduction. Improvement in these types of efficiency/criteria can potentially increase revenue and profits. Therefore, higher efficiency means higher operational performance, and this would lead to better financial performance (Fig. 1).

H5. Operational performance is positively related with financial performance.

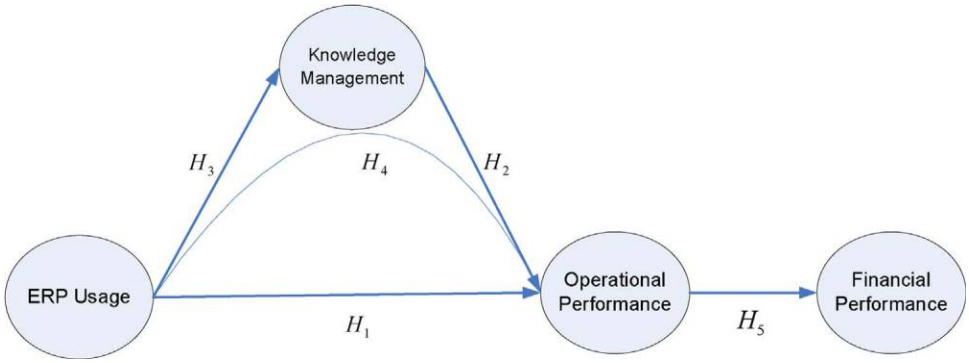

Fig. 1. Proposed model.

3. Research methodology

3.1. Sample data and collection procedure

Survey data was gathered via cross-sectional mail and e-mail surveys using a questionnaire. The questionnaire was developed to measure the underlying determinants of the implementation level KM and ERP usage relying on five-point scales (1: strongly disagree and 5: strongly agree). Moreover, in order to obtain a homogeneous data sample, only manufacturing companies were considered in the research. The firms were mostly selected from the members of Industrial Organized Zones and Chambers of Commerce in highly industrialized cities in Turkey, such as Istanbul, Ankara, Izmir, Kocaeli, Bursa, Sakarya, Konya. Internet sources and social media/social networks were used to reach the managers of these organizations. The identified respondents were all managers related to supply chain operations, such as production planning, warehouse management, information technology experts, and the individuals authorized to assess and purchase/procure large-scale IT resources.

The inquiry was sent to more than 500 managers, of which, nearly 250 responded favorably—expressing their willingness to fill-out the questionnaire. A total of 163 usable questionnaires were actually returned. Thus, 163 responses were subsequently used in the statistical analysis of this investigation. To assess the potential effect of response bias—whether it is significant between those who responded early and those who responded late—in this study, we performed both chi-square tests and *t*-tests. The null hypothesis of these statistical analyses was that an early respondent has the same characteristics as a late respondent. That is, the observed significance level of p-value for all variables came out to be much higher than $p = 0.05$ level, suggesting that there was no response bias between those who responded early and those responded late.

As far as the sample characteristics are concerned, sixteen respondents were production managers, thirty-three respondents were information technology (IT) managers, twenty-two of the responders were members of board, CEOs or assistants of CEOs, and the remainder of respondents were in different managerial and technical positions, such as engineering, supply chain management and quality management. Additionally, the corporations were of different sizes: one of them was a micro-sized organization, eighteen of them were small-sized companies (having less than 50 employees), ninety-five of them were medium-sized companies (having less than 250 employees), fourth-three of them were big companies, and the remaining four firms did not specify their number of employees.

3.2. Measurement of variables

Statements in the questionnaire about KM practices are mostly adapted from a previously conducted study by Zaim, Tatoglu, and Zaim (2007). The factors of the questionnaire scale are set as knowledge generation, knowledge transfer, knowledge utilization, and coding and storage of knowledge processes. These four processes logically appear to explain and sustain KM efficiency. The questions were originally designed for knowledge management processes in an organization. However, in this research, knowledge management among supply chain members is considered, so the questions were modified according to this perspective. Additionally, some arguments were eliminated because they were not suitable for the aims of this research. The respondents were asked to provide their opinions about KM on a scale from 1 (strongly disagree) to 5 (strongly agree).

Usage of different ERP modules was considered when generating the questions, and three basic ERP modules about operations were taken into account: supply chain, production planning, and quality assurance. Additionally, some questions were modified by using the questions of Sternad, Gradisar, and Bobek (2011). Originally, the statement, '*The ERP system provides sufficient information to our organizational needs',* was in the study, and it was changed to '*The ERP Production/Quality/Supply Chain module provides sufficient information to our organizational needs'*. Moreover, these statements were checked by two ERP experts, and they confirmed their suitability. The respondents were asked to check their opinion about statements with scaling from 1 (strongly disagree) to 5 (strongly agree).

Performance criteria were selected by reviewing the literature related to business performance (e.g., Kroes and Ghosh, 2010; Zaim et al., 2007). However, because of the similarities among performance criteria, statements were redesigned primarily to assess supply chain performance and financial performance. Non-financial criteria, common to supply chain operations, include delivery on time, forecasting accuracy, lead time, service after sale and average inventory level. The financial criteria used were profit, revenue and return on investment. Questions regarding corporate performance were based on the last three years of information. The respondents were asked to indicate their judgments about performance on a scale from 1 (very bad) to 5 (very good).

4. Analysis and results

Interrelationship among ERP Usage, KM, operational and financial performance constructs and the mediating impact of KM on the relationship between ERP Usage and operational performance within the context of the manufacturing sector were investigated using a covariance based structural equation modeling (SEM) approach. The individual steps of the SEM methodology employed for this study are explained and briefly discussed in the following sub-sections.

4.1. Exploratory factor analysis

In this study, we tested the unidimensionality of KM and ERP Usage constructs by analyzing the results of a principal component analysis (PCA) in the exploratory factor analysis (EFA). Firstly, this analysis was

Table 1
EFA and CFA for KM.

Symbol	Variable	KG	KS	KUS	Weight
KM1	The R & D activities in our business related to supply chain are at satisfactory level.	0.682			.73**
KM2	Employees in supply chain departments are encouraged for continuous learning.	0.797			.82*
KM3	Our business makes effort to find qualified personnel for supply chain departments.	0.760			.71*
KM4	Our business encourages and supports innovative ideas related to supply chain operations.	0.724			.70*
KM5	In our business, brainstorming is conducted to improve current operations and to solve problems.	0.569			.71*
KM6	In our business, employees in supply chain contribute to knowledge generation processes	0.624			.70*
KM7	There is a systematic effort in ourbusiness to generate and improve knowledge.	0.659			.74*
KM8	In our business, information about our suppliers and customers is regularly classified and stored.		0.763		.72**
KM9	In our business, I can easily reach information about supply chain operations.		0.813		.91*
KM10	In our business, information about supply chain operations are regularly updated.		0.813		.89*
KM11	We pay attention to sharing information with our supply chain members.			0.747	.69**
KM12	We improve our business operations through knowledge sharing with our suppliers and customers.			0.803	.85*
KM13	We effectively use internet to share information with our suppliers and customers.			0.736	.71*
KM14	For information sharing purposes, we organize meetings with our suppliers and customers.			0.595	.70*
KM15	There is a strong communication between us and ours uppliers and customers.			0.698	.74*
KM16	We reflect our knowledge and experience on our services and products.			0.610	.83*
KM17	We are a business that continously learns, and implements what is learned.			0.568	.75*

* Significant for $p < 0.01$.
** Reference variable.

applied for KM. There were 18 indicators related with KM, and those factors with eigenvalues greater than 1 were considered. After the first step, KM17 ('We are a business that continously learns, and implements what is learned') was dropped. At the end of second step, 17 items were loaded on three different factors (Table 1). Based on the loadings, these factors were named as knowledge generation (KG), knowledge storage (KS) and knowledge usage/sharing (KUS). The Cronbach α values are 0.73, 0.88, 0.90, respectively. These values are greater than the threshold value of 0.7 (Nunnally & Bernstein, 1994). All these factors were also mentioned in the research of Zaim et al. (2007), so the analysis conforms to the recommendations of the literature.

Furthermore, 9 indicators of ERP usage were loaded on two different factors as in Table 2. These factors are named as Modules of ERP (MO) and Utility of ERP (UTIL). The Cronbach α values are 0.86 and 0.73 respectively. These values are greater than the threshold value 0.7 (Nunnally and Bernstein, 1994), so they were used in the analysis.

4.2. Confirmatory factor analysis

Confirmatory Factor Analysis tests the measurement model of variables. Therefore, KM and ERP Usage were tested with a first order confirmatory factor model to evaluate the construct validity. Based on the results, it can be said that factor structures for KM and ERP usage obtained from CFA were supported. The measurement model for KM and ERP usage is summarized in the following and the regression weights for all variables constituting each dimension were also found to be significant ($p < 0.05$).

Table 2
EFA and CFA for ERP usage.

Symbol	Variables	MO	UTIL	Weight
ERP1	We effectively use the ERP Production module.	0.82		.83**
ERP2	ERP Production module gives necessary information about production processes.	0.81		.76*
ERP4	We effectively use the ERP Supply Chain module.	0.82		.71*
ERP5	ERP Supply Chain module gives necessary information about production processes.	0.70		.69*
ERP7	We effectively use the ERP Quality module.	0.74		.61*
ERP8	ERP Quality module gives necessary information about production processes.	0.66		.58*
ERP3	The lack of ERP Production module is a serious loss for us.		0.75	.71**
ERP6	The lack of ERP Supply Chain module is a serious loss for us.		0.87	.76*
ERP9	The lack of ERP Quality module is a serious loss for us.		0.75	.63*

* Significant for $p < 0.01$.
** Reference variable.

The goodness-of-fit indices for KM and ERP Usage reveal that the value of X^2/df are 1.83 and 3.50, respectively. According to Hair, Black, Babin, and Anderson (2012), this ratio (i.e., X^2/df) need to be between 0 and 5 for acceptability (whereas values lower than 2 is considered excellent). Moreover, goodness of fit index (GFI), adjusted goodness of fit index (AGFI), Tucker-Lewis coefficient (TLI) and comparative fit index (CFI) values for KM and ERP usage are highly satisfactory because these indices should be close to 1 to show a perfect fit (Demirbag, Koh, Tatoglu, & Zaim, 2006). For KM construct, these values are 0.86, 0.81, 0.93 and 0.94; for ERP practices construct they are 0.93, 0.81, 0.88 and 0.94, respectively.

4.3. Common method bias

Since gathering data from multiple data sources for each of the entities (namely organizations) brings high cost, in this study data is collected from single respondents at the same time it aims to minimize common method variance by utilizing surveys. Thirteen factors with eigenvalues greater than one are able to explain 37.6 percent of the total variance. According to the above mentioned test results common method bias is not considered as statistically significant.

4.4. Structural analysis

The final step in the analysis is to test the path model. The hypothesized structural equation model is tested with AMOS software package.

The goodness-of-fit indices for this model are at acceptable level: Satorra-Bentler X^2/df = 1.79; GFI = 0.90; AGFI = 0.85; TLI = 0.91; CFI = 0.93; RMSEA = 0.07. When ERP Usage is considered, the modules criteria appear as the most important factor, with a standardized regression weight of β = 0.83. The standardized regression weight that belong to the Utility criteria is 0.43 and this criterion has a lower impact than the modules criterion on ERP. Secondly, knowledge usage and sharing appear to be the leading factor for KM with the value of β = 0.88. Additionally, knowledge generation was the second most critical factor for KM which is β = 0.83, and lastly, knowledge storage has comparatively less impact on KM (β = 0.74).

For operational performance, service after sale was the leading factor (β = 0.68), and delivery on time (P5) appeared as the second

Table 3
Results of the hypotheses.

Hypothesis	Path	Std. Path Coefficient	Result
H1	ERP → OPER	0.07	Not Supported
H2	KM → OPER	0.70*	Supported
H3	ERP → KM	0.66*	Supported
H4	ERP → KM → OPER	0.66*0.70 = 0.46*	Supported
H5	OPER → FIN	0.67*	Supported

* Significant for $p < 0.01$.

most important factor, with the value of $\beta = 0.59$. Lead time (P3) had a comparatively lower impact on operational performance of $\beta = 0.50$. Forecasting accuracy (P2) and average inventory level (P4) factors were less important than other factors with the value $\beta = 0.45$ and $\beta = 0.43$, respectively. Last but not least, financial performance was explained by three factors, and profit is the most crucial criteria of these at $\beta = 0.78$, Second, revenue had a significant effect on financial performance with the value of $\beta = 0.77$. Finally, return on investment had the least significant impact, at $\beta = 0.74$.

Results of the five hypotheses and related coefficients are shown in Table 3. As it can be seen, the first hypothesis, which is that ERP Usage is positively related with OPER, is not supported and the standardized regression weight for this relationship is not significant ($\beta = 0.07$; $p = 0.56 > 0.01$). This result is similar to other research in the literature that asserts no direct positive impacts of ERP on operational performance (Etezady, 2011; Hendricks, Singhal, & Stratman, 2007; Li, Yang, Sun, & Sohal, 2009); however, it contrasts with some research that support the positive effects of ERP on performance (Bendoly and Jacobs, 2004; Muscatello et al., 2003; Su and Yang, 2010).

The second hypothesis is that KM has a positive effect on OPER. This hypothesis is accepted according to the calculated values ($\beta = 0.70$, $p < 0.01$). The third hypothesis, seeking a positive relationship between ERP Usage and KM, is also supported with a standardized regression weight of $\beta = 0.66$ ($p < 0.01$). This result means that ERP usage trigger the development of concentration level on knowledge management. Furthermore, the hypothesis that mediating by KM, ERP Usage has a stronger effect than the direct effect of ERP usage on OPER is also accepted, because the $\beta_{\text{ERP-KM-OPER}}$ value is statistically significant; however, $\beta_{\text{ERP-OPER}}$ is not. Finally, the fifth hypothesis that states there is a positive relationship between OPER and FIN, is also supported ($\beta = 0.67$, $p < 0.01$).

5. Discussion and managerial implications

From the results of this study, it can be observed that KM is crucial for manufacturers to efficiently use/leverage ERP, because ERP had no direct effect on OPER. However, with a mediating effect of KM, ERP provided an advantage for organizations. It implies that, if a firm simply uses ERP, without KM, managers may not identify the problems within an organization, and ERP can not bring competitive advantages to the corporation. Data obtained from an ERP should be used for knowledge generation in meetings, discussions, and brainstorming. Then, these exchanges can be used to improve efficiency in organizations. Additionally, an ERP may be used for knowledge sharing intra-and-inter organizationally, because it provides an infrastructure for communications among workers, managers, departments and companies. Especially in the last years, ERP has been improving with today's technologies, and it transforms to ERP II and ERP III through use of the internet in operations. Therefore, nowadays members in the supply chain can communicate with each other via an ERP and internet connections. For instance, suppliers can see updated orders, production planning, and inventory levels of a focal firm through its ERP program using the internet, and they arrange their plans according to this information. In the past, an ERP was only implemented within an organization; however, today's situation allow interorganizational connections.

The analysis also showed that KM is positively related to operational performance; so managers should consider the impact of KM on supply chain activities. Members of a supply chain should collaborate and play a role in joint programs to generate knowledge. These processes can provide the elimination of inefficient points in the chain, because lack of communication among organizations is one of the most crucial problems in the business world.

A knowledge repository provides different advantages to parties of a supply chain such as: learning of different solutions for specific problems, collaboration and providing a meeting environment to discuss special topics within forums and communication of managers in different factories, cities, countries, etc. for common projects. For example, assuming that a big automotive producer company has more than a hundred suppliers; if it establishes a knowledge repository system for itself and its suppliers, one of its contractors can input the solution to any specific accounting problem between them, and in the future when another supplier faces the same issue, it may easily find the remedy and overcome the problem. Therefore, organizations may generate knowledge and share their experiences through knowledge repository systems.

Moreover, Total Quality Management (TQM) can be considered as one of the perspectives and practice areas of Knowledge Management. According to this popular management philosophy, all departments in organizations are responsible for perpetual improvement of efficiency and quality in their operations with an eye towards continuous improvement and perfection of the business processes. Therefore, top managers are advised to establish organization-wide TQM philosophies within their firms in association with KM and ERP.

To recap, knowledge generation through discussions, meetings and brainstorming is expected to bring new and creative ideas and solutions to problems and opportunities that companies are facing. Business Process Reengineering (BPR) or other continuous improvement processes for quality management are examples of knowledge generation processes. With the help of technology such as software, ERP, servers etc., organizations can code, store and share their knowledge. After the generation of new ideas or problem solutions, organizations can decrease their costs, increase profits and improve their efficiencies. Therefore, KM may enhance their competitive advantages against rivals.

When the results are considered, it can easily be observed that ERP has no direct effect on OPER; this means that an ERP brings no advantages directly. In fact, this realization is surprising, but in the literature there is some support for this issue (Brynjolfsson, 1993; Davenport, 1998; Li et al., 2009). Since IT occurs from different parts of the organization and through various software, lacking of any section or part may cause an interruption in ERP utilization. For instance, if any SME uses ERP with only few modules, it can not take full advantages of using ERP. Therefore, firms should struggle to implement ERP fully in their organizations.

Additionally, when using ERP in its simplest form, it may not bring competitive advantage for organizations. Since ERP is applied to existing systems, inefficiencies or problems may not be eliminated during and after ERP implementation. To prevent these types of troubles of an ERP, the ERP implementation process must be well organized, experts of ERP vendors and managers of firms need to collaborate and plan projects together in detail, and problems need to be addressed as quickly as possible, perhaps through KM approaches. Thus, this research indicates that ERP and KM are complementary rather than conflicting. ERP focuses on efficiency and KM considers flexibility, but application of these simultaneously in organizations is possible, and KM enhances the effect of an ERP on operational performance. Data received from an ERP may be used to generate knowledge, define and eliminate problems and then improvement in efficiency may be provided by managers through KM and the ERP system.

6. Summary and conclusion

The aim of this research is to investigate the direct and indirect effects of Enterprise Resource Planning (ERP) usage with the mediating effect Knowledge Management (KM) on performance. The study is based on survey data collected from manufacturing companies. Firstly, factors of latent variables were determined according to exploratory factor analysis (EFA), then reliability and validity of these variables were evaluated with confirmatory factor analysis (CFA). In the next step, unidimensionality was tested for three variables and hypotheses were evaluated with the PLS method.

ERP and KM should have a stronger positive effect on performance in supply chain-oriented firms because, according to the resource bundling perspective, combining KM and ERP brings many benefits to organization. The path analysis showed that KM has significant and positive effects on operational performance, while ERP by itself does not. Furthermore, indirect effects of ERP Usage with the mediating effect of KM is significant and stronger than their direct impacts alone. Also, operational performance influences financial performance positively. Although much research has been interested in the effects of KM and ERP Usage on performance solely, this study indicated the importance of their simultaneous effects. Moreover, the research showed that ERP and KM are complementary rather than conflicting.

Although, this has been an intensive, time-demanding, fruitful study, is also has some limitations. Since only manufacturing companies were considered, the results may not generalize to service type organizations. Even though the sample size was sufficient for the underlying study, a larger sample would have opened up other investigative avenues. By limiting the domain to only manufacturing companies, we aimed at maintaining a certain level of homogeneoty. It was also hard to collect data from a larger number of companies and participants. In future research, service type organizations can also be considered, and obtained results can be compared to those of the ones obtained in this study for the manufacturing sector. Moreover, the mediating effect of ERP for the relationship between KM and OPER can also be considered and analyzed. Like the analysis of quantitative data, collection and analysis of qualitative data may provide an important complement to these studies in social sciences.

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