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# The Relationship Between Knowledge Management and Innovation Performance

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ABSTRACT

This study examines the quantitative relationship between knowledge management, innovation, and performance. We aim to shed some light on the consequences of Knowledge Management (KM) activities on firm's innovation and performance. Organizations are unaware of real implications of KM. According to the literature review, we develop a research model showing a positive relationship between knowledge management, and performance as well as its impact on innovation, which in turn contributes to the firm's performance. Using data from 120 firms that are members of the Iranian Power Syndicate, this model was tested empirically. Based on the Structural Equation Model (SEM) results by Partial Least Square (PLS) method, research hypotheses were supported. Results show that KM activities impact innovation and organizational performance directly, and indirectly through an increase in innovation capability. It is found that knowledge creation, knowledge integration, and knowledge application facilitate innovation and performance. Knowledge creation has more significant effects on innovation speed, innovation quality, and innovation quantity, whereas innovation quality, knowledge creation, and knowledge integration has more significant effects on performance. Findings presented in this paper may help academics and managers in designing KM programs to achieve higher innovation, effectiveness, efficiency, and profitability.

## 1. Introduction

"The modern corporation, as it accepts the challenges of the new knowledge-based economy, will need to evolve into a knowledge-generating, knowledge-integrating and knowledge protecting organization" (Teece, 2000, p. 42). Hence, firms have to continuously work on their specific capabilities, (e.g. dynamic capabilities) to stay competitive. (Teece & Pisano, 1994). Skyrme (2001) defines Knowledge Management (KM) as 'the explicit and systematic management of vital knowledge, and its associated processes of creation, organizing, diffusion, and exploitation'. From the practice perspective, firms are noticing the importance of managing knowledge if they want to remain competitive (Zack, 1999), and grow (Salojärvi, Furu, & Sveiby, 2005).

In the era of knowledge-based economy, resources and competencies are expected to be the crucial factors for organizations to survive in dynamic and competitive environment (Subramaniam & Youndt, 2005; Teece, Pisano, & Shuen, 1997). After pointing out that knowledge is an alternative to equipment, capital, materials, and labor to become the most important element in production, Drucker (1993) predicted that competitive advantage in future is determined by knowledge resources, or what is known as

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knowledge workers.

In the dynamic capabilities approach that roots in the resource-based view of the firm by Penrose (1959), a pivotal role for strategic management is opened (Kor & Mahoney, 2004). Among the management objectives proposed by this approach, the management of a firm's knowledge resources, with respect to a firm's innovativeness, has increasingly attracted attention over the last decade. An increasing amount of research on innovation and strategic management puts knowledge in the center of interest (Darroch, 2005; Davenport, De Long, & Beers, 1997; Grant, 1996; Hall & Andriani, 2002; Hargadon, 1998; Nonaka & Takeuchi, 1995; Swan, Newell, Scarbrough, & Hislop, 1999). In the innovation literature, knowledge is discussed as the element of a recombination process to generate innovation (Galunic & Rodan, 1998; Grant, 1996). Knowledge has an inherent value to be managed, applied, developed, and exploited. Knowledge can be seen as an asset that raises traditional asset questions to management such as when, how much, and what to invest in. As the necessary intangible assets for any organizations, knowledge should be elaborately managed. Consequently, both scholars and practitioners have increasingly paid great attention to an organization's ability to identify, capture, create, share, or accumulate knowledge (Jang, Hong, Bock, & Kim, 2002; Kogut & Zander, 1996; Michailova & Husted, 2003; Nonaka & Takeuchi, 1995). Owing to the particular properties of knowledge, however, knowledge assets require special attention. Knowledge is often embedded in employees, has features of a public good (Jaffe, 1986, p. 984; Liebeskind, 1997), and can hardly be bought in the market (Hall and Mairesse, 2006, p. 296). Therefore, innovating firms need a sophisticated Knowledge Management (KM) that pays a lot of attention to the special requirements of interactive knowledge, and dimensions of knowledge (creation). Particularly in the emerging distributed organizations, effectiveness is highly dependent on how well knowledge is shared between individuals, teams, and/or units (Alavi & Leidner, 2001; Argote & Ingram, 2000; Huseman & Goodman, 1998;Pentland, 1995). Knowledge sharing behaviors have been argued to contribute to the generation of various organizational capabilities such as innovation, which is vital to a firm's performance (Kogut & Zander, 1996). The importance of KM and its relationship with innovation is widely acknowledged. However, it is difficult to draw conclusions from the extant literature about the relationship between effective KM, innovation, and performance. Empirical work, however, is still in its infancy, and characterized by heterogeneous measurement approaches (Hall and Mairesse, 2006, p. 296). Various studies on technological (ICT-based) (Adamides & Karacapilidis, 2006), human resource (Carter & Scarbrough, 2001), or social aspects (Gupta & Govindarajan, 2000) of KM exist, focusing on innovation types in general (Darroch, 2005). Despite the importance of these results, approaches that attempt to measure firms' success with innovations achieved through KM when innovation success is quantified (measured in economic terms such as sales generated) are still scarce. The first step to fill this gap in the literature is presented in this paper.

This study aims to examine the relationships between knowledge management activities, innovation, and firm performance from a holistic perspective. According to a survey including 226 experts from 120 enterprises in Iran, which are the members of Iranian power syndicate, this study employed modeling to investigate the research hypotheses within their organizations.

Thus, the following questions may arise: whether Knowledge creation, knowledge integration, knowledge application influences firm performance directly? What are the key factors affected by knowledge management activities that lead to firm performance? Does KM, through innovation, have an impact on a firm's success? According to knowledge management literatures, this paper argues that Knowledge creation, knowledge integration, and knowledge application not only have positive relationship with firm performance directly but also influence innovation speed, quality and quantity that are related to firm performance.

The remainder of this paper proceeds as follow: Section 2 presents the literature review for introducing key constructs of our research. Section 3 develops a research model to depict hypothesized relationships. Section 4 provides research methodology and data collection. Data analysis and the findings are reported in Section 5. Finally, conclusions, limitations and further research suggestions are presented in Section 6.

## 2. Literature Review

Our literature review is centered on our main research question: “Does KM have impacts on a firm's success through innovation?” Before reviewing studies dealing with the link between KM and the success of innovation activities, we start our literature review with papers related to definitions and forms of KM.

### *2.1. Knowledge Management*

Gold, Malhortra, and Segars (2001) examined the issue of effective Knowledge Management (KM) from the perspective of organizational capabilities. This perspective states that a knowledge infrastructure including technology, structure, and culture along with a knowledge process architecture of acquisition, conversion, application, and protection are essential organizational capabilities, or “preconditions” for effective knowledge management. The results provide a basis to understand the competitive predisposition of a firm as it enters a program of KM. Cui, Griffith, and Cavusgil (2005) also mentioned that KM capabilities consist of three interrelated processes: knowledge acquisition, knowledge conversion, and knowledge application (Gold et al., 2001). Knowledge is not only an important resource of a firm, but it also is a main source of competitive advantage (Gold et al., 2001; Grant, 1996; Jaworski & Kohli, 1993). Therefore, KM capabilities refer to the knowledge management processes that develop, and use knowledge within a firm (Gold et al., 2001).

Several definitions have been around KM (Alavi & Leidner, 2001; Coombs & Hull, 1998; Davenport & Prusak, 1998; Nonaka & Takeuchi, 1995; Probst, Raub, & Romhardt, 1999). Different approaches to KM concentrate on the creation, diffusion, storage, and application of existing, or new knowledge (e.g. Coombs & Hull, 1998). Wiig (1997) puts his emphasis on the management of existing knowledge, Wiig states that the purpose of KM is “to maximize the enterprise's knowledge related effectiveness and returns from its knowledge assets, and to renew them constantly" (Wiig, 1997, p. 2). Davenport and Prusak (1998) stress that KM consists of making knowledge visible and developing a knowledge-intensive culture. Several studies identified acquisition, identification, development, diffusion, usage, and repository of knowledge as core KM processes (e.g. Alavi & Leidner, 2001; Probst et al., 1999). Swan, Newell, Scarbrough, et al. (1999) argue that knowledge exploration and exploitation are the core objectives of KM. KM implementation can be divided into IT-based KM, and human-resource-related KM, as well as process-based approaches (Tidd, Bessant, & Pavitt, 2001).

IT-based or supply-driven KM emphasizes the need for (easy) access to existing knowledge stored in databases, or elsewhere (Swan, Newell, Scarbrough, et al., 1999). In contrast, the demand-driven approach is more concerned with facilitating interactive knowledge sharing, and knowledge creation (Swan, Newell, Scarbrough, et al., 1999).

Although there are still many classifications of KM, this study prefers three Dimensions of knowledge. These dimensions are as follow:

1. Production of Knowledge including knowledge acquisition, and knowledge creation
2. Integration of Knowledge including knowledge storage, and knowledge distribution
3. Application of Knowledge including protection, and use of knowledge

### *2.2. Organizational Innovation*

Basically, there are two types of innovation: product and process innovation (Dosi, 1988; Teece, 1989; Utterback & Abernathy, 1975). These are not mutually preclusive, but depend on each other in a major degree. Process innovations can furthermore be divided into organization (i.e. new market organization and internal company organization), and technology (i.e. human artifacts). Technology can be classified as three entities (Gehlen, 1980, p. 19): instrument, machine, and automaton. This concept of technology separates us from Johnson (1992, p. 28), among others, where he makes the following statement: "knowledge used in the production process is called technology". This question should be asked from Johnson: what about "tacit knowledge"? If "tacit knowledge" is also a part of the technology concept, technology will lose its analytical purpose. This also applies if all explicit knowledge is included in the technology concept.

Innovation can also be seen as incremental (i.e. small step-by step improvements, or continuous innovation), or radical (i.e. something qualitatively new, or a breakthrough) (Dewar & Dutton, 1986; Ettlie, Bridges, & O'Keffe, 1984; Freeman, 1992; Mansfield, 1968; Mokyr, 1990; Zaltman, Duncan, & Holbek, 1973). Continuous and radical innovation can also be autonomous. One example of autonomous innovation is "snowboard". One example of systemic innovation is IBM's OS/2, which presupposed change in other systems in the value chain.

The growth innovation literature provides many alternative conceptualizations and models for the interpretation of observed data. An innovation can be a new product or service, a new production process technology, a new structure or administrative system, or a new plan or program pertaining to organizational members. Therefore, organizational innovation or innovativeness is typically measured by the rate of innovation adoption. A few studies, however, have used other measures to measure organizational innovativeness (Damanpour, 1991). Former research has argued that different types of innovation are necessary for understanding and identifying in organizations.

Among numerous typologies of innovation in the literature, three have gained the most attention. Each centers on a pair of types of innovation: administrative and technical, product and process, and radical and incremental. Wang and Ahmed (2004) identified organizational innovation through an extensive literature. These five dimensions are tested from component factors. They are product innovation, market innovation, process innovation, behavioral innovation, and strategic innovation. Although there are still many classifications of innovation, this study prefers three aspects of innovation:

1. Innovation speed;
2. Innovation quality; and
3. Innovation quantity.

Innovation speed, which is defined as the time elapsed between initial development, including the conception and definition of an innovation, and ultimate commercialization of a new product or services into the marketplace, reflects a firm's capability to accelerate activities and tasks, build a competitive advantage relative to its competitors within industries with shortened product life cycles (Allocca & Kessler, 2006; Kessler & Bierly III, 2002; Kessler & Chakrabarti, 1996). Emphasis on innovation speed represents a paradigm shift from traditional sources of advantage to a strategic orientation, specifically suited for today's rapidly changing business environments. Innovation speed is a crucial element to compete in the market and can lead to superior performance. Empirical studies confirm a positive relationship between speed-to-market and overall new product success (Carbonell & Escudero, 2010; Carbonell & Rodriguez, 2006; Carbonell & Rodriguez-Escudero, 2009). Since innovation speed is a team embodied and socially complex capability- that cannot be easily developed or imitable by competitors (Slater & Mohr, 2006)- it enables firms to keep in close touch with customers, and their needs (Tatikonda & Montoya-Weiss, 2001). Furthermore, the increasing rate of competition, technological developments in the marketplace, and shorter product life cycles force companies to hasten innovation (Heirman & Clarysse, 2007).

The concept of innovation quality allows us to make a statement regarding the aggregated innovation performance in every domain within an organization, by comparing the result, being a product, process or service innovation, with the potential and considering the process on how these results have been achieved (Haner, 2002; Lanjouw & Schankerman, 2004). With respect to products or services, innovation quality may be defined through variables such as effectiveness, features, reliability, timing, costs, complexity, innovation degree, value to the customer, and more. Similar are the things with respect to the process domain of innovation quality. Although innovation quality is one of the most important factors for the company that applies innovation strategy to compete in the market, determining it might be faced with more challenges due to the increased complexity, the difficulty to identify catalysts, and the need to integrate measurements on so-called soft issues(e.g. relative citation ratio, citation- weighted patents, science linkage, scope of innovations, and so on) (Lahiri, 2010; Ng, 2009; Tseng & Wu, 2007).

Quantity innovation is defined as the number of new or improved products and services launched to the market that are superior to the average of the industry. It also is defined as the number of new or improved processes that are superior to the average of the industry.

Organizational interest in KM is stimulated by the possibility of subsequent benefits such as increased creativity, and innovation in products and services (Darroch, 2005; Moffett, McAdam, & Parkinson, 2002). In fact, knowledge contributes to producing creative thoughts and generating innovation (Borghini, 2005). That is why innovation is seen as the area of greatest payoff from KM (Majchrzak, Cooper, & Neece, 2004).

### *2.3. Knowledge Management and Innovative Success*

Looking at the relationship between KM and innovation activities we first draw on Schumpeter. According to him, innovation is the result of a recombination of conceptual and physical materials that were previously in existence (Schumpeter, 1935). In other words, innovation is the combination of a firm's existing knowledge assets to create new knowledge. Therefore, the primary task of the innovating firm is to reconfigure existing knowledge assets and resources, and to examine new knowledge (Galunic & Rodan, 1998; Grant, 1996; Nonaka & Takeuchi, 1995). Both exploration and exploitation of knowledge have been shown to contribute to the innovativeness of firms, and to its competitive advantage (Hall & Andriani, 2002; Levinthal & March, 1993; March, 1991; Swan, Newell, Scarbrough, et al., 1999). Various studies focus on the role of KM in the innovation process. The results found by Liao and Chuang (2006) support the vital role of KM in knowledge processing capability and in turn, in speed and activity of innovation. Huergo (2006) provides evidence to support the positive role of technology management in success of firm innovations. A different approach is applied by Yang (2005). He assumes that moderating effects of marketing and manufacturing competencies, knowledge acquisition, knowledge dissemination, knowledge integration, and knowledge innovation improve new product performance. This finding is supported by Brockman and Morgan (2003). They argue that the KM tools such as “use of innovative information”, “efficient information gathering” and “shared interpretation” improve the performance and innovativeness of new products. With regard to special focus on “demand-driven”,or “collaborative” KM methods, theoretical considerations provide ambiguous arguments. Alavi and Leidner (2001) argue that excessively close ties in a knowledge-sharing community may limit knowledge creation due to redundant information. On the other hand, Brown and Duguid (1991) and Nonaka, Toyama, and Konno (2000) make the case that a shared knowledge base increases knowledge creation within the community. Empirical case study evidence shows mixed results as well. Findings of Darroch et al. are a good example. Darroch (2005) confirms the positive role of knowledge dissemination on innovation success, while Darroch and McNaughton (2002) do not find any significant effects. Another aspect of the link between KM and innovation is how different types of innovation are affected by KM. According to Darroch and McNaughton (2002) different types of innovation require different resources and hence a differentiated KM strategy. They investigate the effects of KM on three types of innovation. According to their findings different KM activities are important for different types of innovative success. Hence, we expect that KM acts differently on different type of innovation success, as well as speed, quality, and quantity innovation success.

## 3. Consequences of KM and Innovation Success

### *3.1. Effects of KM on innovation*

The innovative efforts include discovery, experimentation, and development of new technologies, new products and/or services, new production processes, and new organizational structures. Innovation is about implementing ideas (Borghini, 2005). The Literature (Daft, 1982; Damanpour & Evan, 1984) describes innovation as internally acquired element, new structure or administrative system, policy, new plan or program, new production process, and product, or service to a company. Innovation process highly depends on knowledge (Gloet & Terziovski, 2004), specially tacit knowledge (Leonard & Sensiper, 1998). Transforming general knowledge into specific knowledge, new and valuable knowledge is created and converted into products, services, and processes (Choy, Yew, & Lin, 2006). Studies on knowledge creation by Nonaka consider knowledge as a main requisite for innovation and competitiveness (Nonaka, 1994). A KM system that expands the creativity envelope is thought to improve the innovation process through quicker access and trend of new knowledge (Majchrzak et al., 2004). Also, effective KM is a critical success factor to launch new products. In this sense, this paper supports that one of the factors influencing innovation capacity in organizations is knowledge, and its management. Darroch (2005) provides empirical evidence to support the view that a firm with a capability in KM is also likely to be more innovative. Also, Massey, Montoya-Weiss, and O'Driscoll (2002) tell the story of a real company that implemented a KM strategy, and enhanced innovation process and performance. Swan, Newell, and Robertson (1999) also compared the impact on innovation in different KM programs implemented in two organizations.

Thus, a close link between the organization's knowledge and its capacity to innovate exists (Borghini, 2005). A few empirical research has specifically addressed antecedents and consequences of the production, Integration, and Application of Knowledge in innovation, and performance. The management of knowledge is frequently identified as an important antecedent of innovation.

Effective KM is presented in the literature as a method for improving innovation and performance. We obtained the result that KM processes positively affect innovation. Therefore, it is fair to conclude that KM process and innovation are closely related. Thus, we posit the followings:

**H1.** The production of knowledge has a direct and significant effect on speed innovation.

**H2.** The Integration of Knowledge has a direct and significant effect on speed innovation.

**H3.** The Application of Knowledge has a direct and significant effect on speed innovation.

**H4.** The production of knowledge has a direct and significant effect on quality innovation.

**H5.** The Integration of Knowledge has a direct and significant effect on quality innovation.

**H6.** The Application of Knowledge has a direct and significant effect on quality innovation.

**H7.** The production of knowledge has a direct and significant effect on quantity innovation.

**H8.** The Integration of Knowledge has a direct and significant effect on quantity innovation.

**H9.** The Application of Knowledge has a direct and significant effect on quantity innovation.

### *3.2. KM Effects on Organizational Performance*

Prior conceptual research state that KM can improve corporate performance and competitiveness (Civi, 2000; DeTienne & Jackson, 2001; Holsapple & Jones, 2004, 2005). KM programs are successful as corporate performance is improved. Therefore, it is essential to measure KM contributions to performance (Tseng, 2008), especially when there is no conclusive research on the relationship between the production, Integration, Application of knowledge and firm performance (Yang, 2010). Corporate performance is a multidimensional concept and accounts for firm's position regarding to competitors. A comprehensive view of corporate performance not only considers the financial perspective, but also others aspects that allow monitoring value creation. Based on this view some methodologies have been developed. The most popular methodology is the Balanced Scorecard (Kaplan & Norton, 1996). Some studies recognize the impact of strategic KM on different dimensions of corporate performance (McKeen, Zack, & Singh, 2006). Nevertheless, most of them focus on hard financial outcomes (e.g. cost, profit, etc.) to evaluate KM (Vaccaro, Parente, & Veloso, 2010), while ignoring soft non-financial outcomes such as operating costs, shorten lead-time, and differentiate products (Sher & Lee, 2004); developing new services (Storey & Kahn, 2010); improving its ability to attract, train, develop, and retain employee (Thomas & Keithley, 2002); and improving coordination efforts (Wu & Lin, 2009). since diverse dimensions of performance are affected by KM strategy, K M system performance should combine financial and nonfinancial measures (Tseng, 2008; Wu & Lin, 2009). We suggest that the impact of KM strategy on firm performance should be better studied by analyzing different dimensions of corporate performance. Three dimensions will be employed to measure KM contributions to corporate performance: (1) financial performance including market performance (profitability, growth and customer satisfaction); (2) process performance, which refers to quality and efficiency; and (3) internal performance, which relates to individual capabilities (employees' qualification, satisfaction and creativity). Thus, this study proposes:

**H10.** The production of knowledge has a direct and significant effect on organizational performance.

**H11.** The Integration of Knowledge has a direct and significant effect on organizational performance.

**H12.** The Application of Knowledge has a direct and significant effect on organizational performance.

### *3.3. Innovation Effects on Organizational Performance*

Innovation is recognized as a significant enabler for firms to create value and sustain competitive advantage in the increasingly complex and rapidly changing environment (Bilton & Cummings, 2009; Subramaniam & Youndt, 2005). In general, innovation not only makes full use of existing resources, improve efficiency and potential value, but also brings new intangible assets into organization. Firms with greater innovativeness will be more successful in responding to customers' needs, and in developing new capabilities that allow them to achieve better performance or superior profitability (Calantone, Cavusgil, & Zhao, 2002; Sadikoglu & Zehir, 2010). Innovation is critical to achieve operational efficiency as well as raising service quality (Hsueh & Tu, 2004; Parasuraman, 2010). Accordingly, scholars paid more attention to the effects on firm performance (Clifton, Keast, Pickernell, & Senior, 2010; Jenny, 2005; Liao, Wang, Chuang, Shih, & Liu, 2010; Vaccaro et al., 2010).

As time-based competition has become an important concern for contemporary business organizations, more firms recognized that quick response of their competitors to new product development is posing a critical competitive threat. Therefore, they attempt to introduce new products, services, or processes more quickly (Boyd & Bresser, 2008; Smith, 2011). Robinson (1990) demonstrated that over a broad cross-section of industries, firms that stressed innovation speed could increase their market share. When a firm is faster than its competitors in developing, producing and selling new products, it is able to make market segments in association with service quality and operating efficiency. That is because knowledge contained in these innovations is not readily available to competitors (Liao et al., 2010). Therefore, innovation speed guarantees quicker response to environment by launching new products with lower times and costs, which eventually improves firm performance (Tidd, Bessant, & Pavitt, 2005). Innovation quality is another key factor influencing firm performance. A high quality of innovation is adopting numerous new products, processes or practices across a broad cross-section of organizational activities. It requires firms to create synergies among these multiple activity domains. Such synergies should be created in a way that is inimitable, encourages newness and contributes to competitiveness. Organizations benefit from increased ideas. Innovative R&D would be more effective in achieving firm performance goals (Brentani, 2001; Singh, 2008).

Quantity innovation which is defined as the number of new or improved products, services and process launched to the market is superior to the average in your industry. In fact, knowledge contributes to producing creative thoughts and generating innovation (Borghini, 2005). That is why innovation is seen as the area of greatest payoff from KM (Majchrzak et al., 2004). Although the relationships between innovation and firm performance have been discussed, few researches consider the specific effects of innovation speed, quality, and quality on firm's performance. So this paper proposes the hypotheses as follow:

**H13.** Speed innovation has a direct and significant effect on organizational performance.

**H14.** Quality innovation has a direct and significant effect on organizational performance.

**H15.** Quantity innovation has a direct and significant effect on organizational performance.

## 4. Research methodology

### *4.1. Construct operationalization*

To test the research model, a survey was conducted by companies that are members of Iranian Power Syndicate. A structured questionnaire consisting of close-ended questions was developed. Pretest for the instrument was examined by 6 practitioners (CEOs, senior managers, senior experts of five companies), and 5 academics. The questionnaire was localized for Iran. The seven-point Likert scale ranging from "1" (totally disagree) to "7" (totally agree) was employed in the questionnaire. The question items for the constructs are listed in Appendix A.

The variables of this research are measured using multi-item scales, tested in previous studies. The producing of knowledge scales is based on Fong and Choi (2009). A range of studies (Fong & Choi, 2009) were used to determine the item scale of the knowledge integration. The Application of Knowledge is measured based on Fong and Choi (2009). Innovation speed was measured using five items reflecting firm quickness to generate novel ideas, new product launching, new product development, new processes, and new problem solving compared to key competitors. A few studies used similar measures to operationalize firm's response speed to competitive actions (Chen & Hambrick, 1995; Liao et al., 2010). The measurement of innovation quality was developed from Haner (2002) and Lahiri (2010). Five items reflect the newness and creativity of new ideas, products, processes, practices, and management of certain company. Quality Innovation scale is based on Lee and Choi (2003). Finally, performance measures are based on Quinn and Rohrbaugh (1983), Hoque and James (2000), and Choi and Lee (2002, 2003).

### *4.2. Data Collection*

This study examined a sample of 120 firms that are the members of Iranian Power Syndicate. These firms varied in size and industry. The sample has several advantages. First, production, integration, and application of Knowledge in knowledge intensive firms plays a crucial role in facilitating innovation (e.g. designing new products or services in this highly competitive arena). Second, today's dynamic economy depends on the development of innovation. This property makes firms to examine the link between innovation and performance. Data were collected from CEO, senior manager, expert, and senior expert as the key informant due to their knowledge of the firm, access to strategic information, and familiarity with the environment. Informants were promised to obtain a summary of the results if they were interested in this study. 226 questionnaire were collected.

## 5. Results

### *5.1. Results of reliability and validity*

Using SPSS and PLS, we conducted a Structural Equation Model (SEM) to evaluate the overall measurement model, and per construct. Measurement model shows high reliability and validity of the scales (Table 1). Concerning reliability, Cronbach's alpha, Eigen value and Dillon-Goldstein's Rho are above 0.7 level recommended by the literature (Hair, Anderson, Tatham, & Black, 2001). To evaluate the validity of measurement model, convergent validity and discriminant validity were assessed. Convergent validity is the degree to which, factors that are supposed to measure a single construct, confirm each other. We tested convergent validity as recommended by other studies. Except the Integration of Knowledge (which was 0.42), the average variance extracted is above 0.5-the minimum value proposed by Fornell and Larcker (1981). As it is seen in Table 1, the results show that our model meets the convergent validity criteria.

Discriminant validity is the degree to which, factors that are supposed to measure a specific construct do not predict conceptually unrelated criteria (Kline, 2010). We used Fornell and Larcker's approach to assess discriminant validity. In this approach, the AVE for per construct should be higher than the squared correlation between the construct, and any of the other constructs. Table 1 indicates

**Table 1**
The results of reliability and validity basis on the scale measure the constructs in the conceptual model.

| Critical ratio (CR) | Standard error | loadings | perf | i.qaun | i.qau | i.spe | k.app | k.int | k.pro | variables | Constructs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13.191 | 0.048 | 0.634 | 0.452 | 0.324 | 0.448 | 0.285 | 0.529 | 0.529 | **0.634** | k.pro1 | Production of knowledge |
| 15.098 | 0.042 | 0.636 | 0.470 | 0.307 | 0.490 | 0.364 | 0.369 | 0.453 | **0.636** | k.pro2 | |
| 16.331 | 0.043 | 0.699 | 0.500 | 0.228 | 0.401 | 0.414 | 0.471 | 0.592 | **0.699** | k.pro3 | |
| 11.288 | 0.057 | 0.645 | 0.433 | 0.131 | 0.372 | 0.304 | 0.437 | 0.452 | **0.645** | k.pro4 | |
| 22.280 | 0.035 | 0.788 | 0.546 | 0.297 | 0.490 | 0.378 | 0.510 | 0.557 | **0.788** | k.pro5 | |
| 21.683 | 0.035 | 0.754 | 0.566 | 0.293 | 0.486 | 0.396 | 0.446 | 0.519 | **0.754** | k.pro6 | |
| 24.054 | 0.031 | 0.752 | 0.523 | 0.240 | 0.474 | 0.376 | 0.516 | 0.530 | **0.752** | k.pro7 | |
| 29.813 | 0.028 | 0.825 | 0.552 | 0.284 | 0.527 | 0.414 | 0.554 | 0.592 | **0.825** | k.pro8 | |
| 19.931 | 0.039 | 0.768 | 0.545 | 0.390 | 0.562 | 0.437 | 0.533 | 0.589 | **0.768** | k.pro9 | |
| 16.776 | 0.042 | 0.705 | 0.478 | 0.272 | 0.410 | 0.286 | 0.494 | 0.577 | **0.705** | k.pro10 | |
| 9.830 | 0.064 | 0.626 | 0.428 | 0.180 | 0.361 | 0.276 | 0.516 | **0.626** | 0.562 | k.int1 | Integration of Knowledge |
| 8.575 | 0.067 | 0.576 | 0.382 | 0.291 | 0.361 | 0.301 | 0.370 | **0.576** | 0.431 | k.int2 | |
| 9.246 | 0.066 | 0.610 | 0.321 | 0.239 | 0.279 | 0.201 | 0.498 | **0.610** | 0.357 | k.int3 | |
| 10.700 | 0.053 | 0.568 | 0.378 | 0.186 | 0.266 | 0.258 | 0.376 | **0.568** | 0.376 | k.int4 | |
| 9.785 | 0.063 | 0.612 | 0.472 | 0.199 | 0.314 | 0.231 | 0.469 | **0.612** | 0.468 | k.int5 | |
| 9.229 | 0.061 | 0.560 | 0.399 | 0.154 | 0.290 | 0.261 | 0.459 | **0.560** | 0.496 | k.int6 | |
| 15.855 | 0.046 | 0.737 | 0.531 | 0.281 | 0.506 | 0.486 | 0.564 | **0.737** | 0.639 | k.int7 | |
| 16.138 | 0.042 | 0.683 | 0.448 | 0.332 | 0.373 | 0.294 | 0.554 | **0.683** | 0.459 | k.int8 | |
| 10.128 | 0.059 | 0.597 | 0.258 | 0.235 | 0.236 | 0.176 | 0.486 | **0.597** | 0.346 | k.int9 | |
| 17.054 | 0.040 | 0.679 | 0.399 | 0.216 | 0.301 | 0.268 | 0.541 | **0.679** | 0.480 | k.int10 | |
| 19.649 | 0.038 | 0.742 | 0.508 | 0.301 | 0.426 | 0.381 | 0.614 | **0.742** | 0.576 | k.int11 | |
| 15.280 | 0.044 | 0.666 | 0.463 | 0.322 | 0.391 | 0.345 | 0.504 | **0.666** | 0.540 | k.int12 | |
| 22.984 | 0.033 | 0.760 | 0.489 | 0.262 | 0.418 | 0.395 | 0.619 | **0.760** | 0.534 | k.int13 | |
| 13.732 | 0.044 | 0.610 | 0.444 | 0.227 | 0.384 | 0.342 | 0.514 | **0.610** | 0.467 | k.int14 | |
| 11.794 | 0.060 | 0.709 | 0.307 | 0.158 | 0.231 | 0.231 | **0.709** | 0.543 | 0.397 | k.App1 | Application of Knowledge |
| 12.095 | 0.057 | 0.691 | 0.303 | 0.206 | 0.266 | 0.237 | **0.691** | 0.506 | 0.350 | k.App2 | |
| 12.177 | 0.051 | 0.624 | 0.433 | 0.105 | 0.379 | 0.280 | **0.624** | 0.504 | 0.490 | k.App3 | |
| 19.352 | 0.040 | 0.774 | 0.375 | 0.268 | 0.331 | 0.330 | **0.774** | 0.639 | 0.451 | k.App4 | |
| 35.643 | 0.023 | 0.828 | 0.532 | 0.289 | 0.455 | 0.399 | **0.828** | 0.648 | 0.511 | k.App5 | |
| 12.766 | 0.052 | 0.659 | 0.466 | 0.246 | 0.345 | 0.265 | **0.659** | 0.516 | 0.473 | k.App6 | |
| 14.733 | 0.046 | 0.680 | 0.502 | 0.226 | 0.464 | 0.343 | **0.680** | 0.612 | 0.625 | k.App7 | |
| 13.081 | 0.052 | 0.675 | 0.455 | 0.275 | 0.480 | 0.385 | **0.675** | 0.485 | 0.581 | k.App8 | |
| 21.691 | 0.035 | 0.767 | 0.463 | 0.324 | 0.576 | **0.767** | 0.319 | 0.365 | 0.373 | i.spe1 | Innovation speed |
| 33.936 | 0.025 | 0.834 | 0.507 | 0.568 | 0.634 | **0.834** | 0.317 | 0.344 | 0.390 | i.spe2 | |
| 25.202 | 0.032 | 0.798 | 0.422 | 0.453 | 0.572 | **0.798** | 0.283 | 0.321 | 0.331 | i.spe3 | |
| 22.023 | 0.035 | 0.763 | 0.405 | 0.358 | 0.528 | **0.763** | 0.385 | 0.441 | 0.455 | i.spe4 | |
| 16.407 | 0.043 | 0.713 | 0.464 | 0.253 | 0.556 | **0.713** | 0.390 | 0.389 | 0.429 | i.spe5 | |
| 16.014 | 0.045 | 0.721 | 0.500 | 0.351 | **0.721** | 0.581 | 0.413 | 0.407 | 0.447 | I.qua1 | Innovation quality |
| 16.127 | 0.045 | 0.728 | 0.452 | 0.454 | **0.728** | 0.600 | 0.293 | 0.314 | 0.400 | I.qua2 | |
| 19.598 | 0.039 | 0.758 | 0.525 | 0.470 | **0.758** | 0.592 | 0.368 | 0.382 | 0.418 | I.qua3 | |
| 19.838 | 0.038 | 0.757 | 0.541 | 0.384 | **0.757** | 0.521 | 0.398 | 0.419 | 0.475 | I.qua4 | |
| 20.103 | 0.039 | 0.787 | 0.647 | 0.336 | **0.787** | 0.524 | 0.443 | 0.510 | 0.628 | I.qua5 | |
| 45.965 | 0.020 | 0.925 | 0.477 | **0.925** | 0.458 | 0.461 | 0.297 | 0.348 | 0.316 | i.quan1 | Innovation quantity |
| 31.304 | 0.028 | 0.885 | 0.431 | **0.885** | 0.484 | 0.451 | 0.280 | 0.353 | 0.411 | i.quan2 | |
| 22.720 | 0.032 | 0.723 | **0.723** | 0.444 | 0.617 | 0.510 | 0.406 | 0.475 | 0.523 | perf1 | Performance |
| 14.303 | 0.047 | 0.668 | **0.668** | 0.319 | 0.437 | 0.423 | 0.334 | 0.394 | 0.407 | perf2 | |
| 19.575 | 0.041 | 0.804 | **0.804** | 0.351 | 0.546 | 0.429 | 0.445 | 0.476 | 0.557 | perf3 | |
| 16.692 | 0.045 | 0.744 | **0.744** | 0.440 | 0.541 | 0.472 | 0.400 | 0.456 | 0.512 | perf4 | |
| 17.988 | 0.038 | 0.692 | **0.692** | 0.308 | 0.529 | 0.386 | 0.461 | 0.526 | 0.535 | perf5 | |
| 16.252 | 0.043 | 0.703 | **0.703** | 0.431 | 0.494 | 0.343 | 0.437 | 0.495 | 0.485 | perf6 | |
| 25.253 | 0.030 | 0.766 | **0.766** | 0.301 | 0.493 | 0.423 | 0.419 | 0.484 | 0.538 | perf7 | |
| 17.539 | 0.041 | 0.713 | **0.713** | 0.266 | 0.460 | 0.408 | 0.500 | 0.532 | 0.574 | perf8 | |
| 17.252 | 0.037 | 0.639 | **0.639** | 0.339 | 0.481 | 0.303 | 0.339 | 0.348 | 0.367 | perf9 | |
| 16.456 | 0.040 | 0.662 | **0.662** | 0.437 | 0.593 | 0.450 | 0.456 | 0.498 | 0.457 | perf10 | |
| The results (AVE) are > 0.50, except the integration of knowledge which is 0.42 | | | 0.508 | 0.820 | 0.563 | 0.602 | 0.501 | 0.420 | 0.523 | Convergent validity | |
| The results (AVE) are more than the correlation coefficients between constructs | | | 0.713 | 0.906 | 0.750 | 0.776 | 0.708 | 0.648 | 0.723 | Discriminant validity | |
| Results are > 0.70 | | | 0.892 | 0.779 | 0.809 | 0.834 | 0.856 | 0.893 | 0.896 | Cronbach's alpha | |
| Results are > 0.70 | | | 0.913 | 0.903 | 0.868 | 0.884 | 0.891 | 0.911 | 0.915 | Dillon-Goldstein's Rho | |

Bold indicates high numbers of discriminant validity.

that the measurement model has satisfactory discriminant validity.

## 5.2. *The evaluation of structural model*

Structural model (Table 2) supports the existence of Knowledge Management Dimensions: The production of knowledge (items

**Table 2**
Relationships indices between latent variable and manifest variables.

| Coefficient of determination and test them | | | | Independent construct | Dependent construct | Value | Standard error | Critical ratio (CR) |
|---|---|---|---|---|---|---|---|---|
| Variable's $R^2$ | $R^2$ | Standard error | Standard error | | | | | |
| 5.327 | 0.052 | 0.279 | 0.107 | 10.516 | 0.020 | 0.208 | Innovation speed | Production of knowledge |
| | | | 0.094 | 10.123 | 0.019 | 0.195 | | Integration of Knowledge |
| | | | 0.078 | 8.053 | 0.022 | 0.178 | | Application of Knowledge |
| 7.839 | 0.056 | 0.440 | 0.337 | 7.072 | 0.073 | 0.515 | Innovation quality | Production of knowledge |
| | | | 0.070 | 2.099 | 0.060 | 0.126 | | Integration of Knowledge |
| | | | 0.034 | 0.764 | 0.085 | 0.065 | | Application of Knowledge |
| 3.821 | 0.043 | 0.166 | 0.064 | 7.645 | 0.021 | 0.161 | Innovation quantity | Production of knowledge |
| | | | 0.061 | 6.846 | 0.023 | 0.157 | | Integration of Knowledge |
| | | | 0.042 | 5.542 | 0.023 | 0.130 | | Application of Knowledge |
| 14.902 | 0.043 | 0.640 | 0.132 | 23.158 | 0.008 | 0.187 | Performance | Production of knowledge |
| | | | 0.116 | 19.824 | 0.009 | 0.176 | | Integration of Knowledge |
| | | | 0.093 | 18.242 | 0.009 | 0.157 | | Application of Knowledge |
| | | | 0.091 | 13.471 | 0.012 | 0.156 | | Innovation speed |
| | | | 0.140 | 23.284 | 0.008 | 0.193 | | Innovation quantity |
| | | | 0.067 | 12.519 | 0.011 | 0.134 | | Innovation quality |

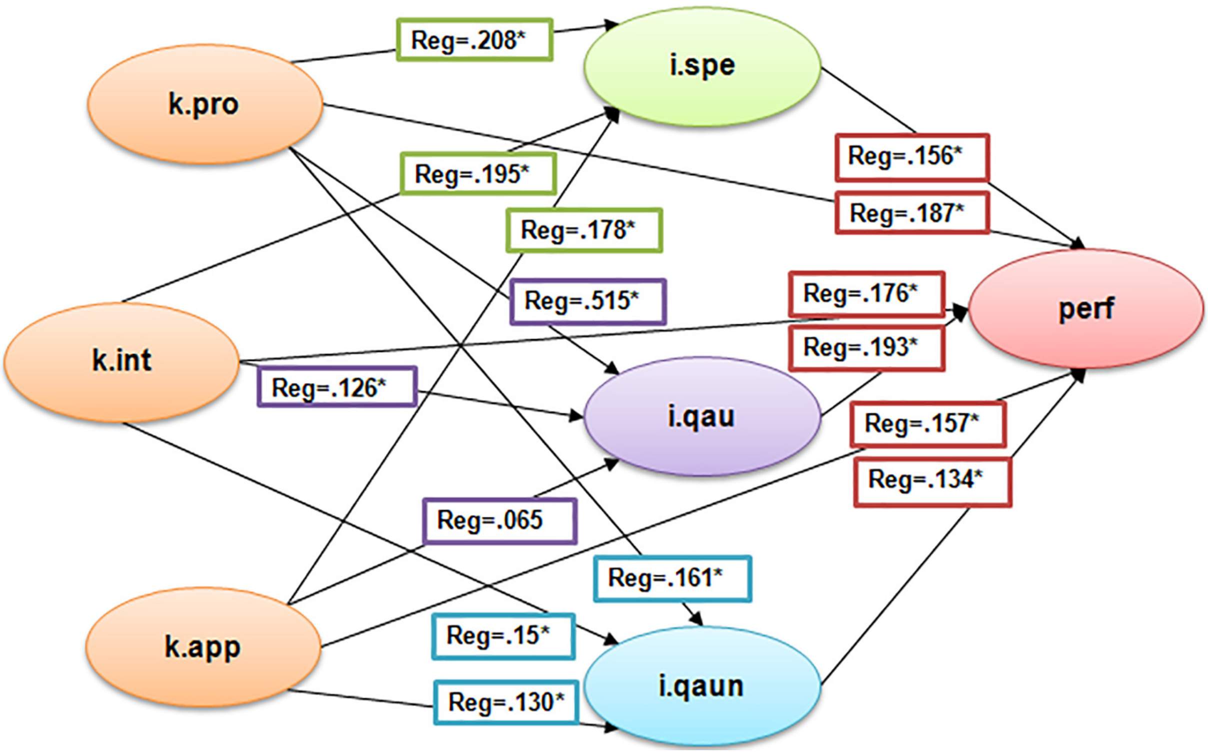


**Fig. 1.** The relationship between exogenous components and Endogenous components.

K.pro1, K.pro2, K.pro3, K.pro4, K.pro5, K.pro6, K.pro7, K.pro8, K.pro9 and KMS10 in Appendix A), The Integration of Knowledge (items K.int1, K.int2, K.int3,K.int4, K.int5, K.int7, k.int8, k.int9, k.int10, k.int11, k.int12, k.int13, k.int14), and The Application of Knowledge (k.App1, k.App2, k.App3, k.App4, k.App5, k.App6, k.App7, k.App8). Second structural model also supports the existence of three innovation variables: speed innovation (i.spe1, i.spe2, i.spe3, i.spe4, i.spe5), quantity innovation (I.qua1, I.qua2, I.qua3, I.qua4, I.qua5), and Quality innovation (i.quan1, i.quan2). Third Structural model also supports the existence of 3 dimensions in the performance variable: financial, process, and internal performance. The idea that corporate performance has a multidimensional nature consisting of financial and non-financial measures is consistent with prior research. Specifically, our financial dimension in performance (items perf1, perf2 and perf3 in Appendix A) is similar to financial perspective proposed in the Balanced Score Card (BSC) by Kaplan and Norton (1996), and model of effectiveness based on rational goal by Quinn and Rohrbaugh (1983). Process dimension in our measure of performance (items Perf4, Perf 5, Perf 6 and Perf 7) combines customer and internal perspectives of the BSC, and the internal process model by Quinn and Rohrbaugh (1983). Finally, our internal dimension of performance (items Perf 8, Perf 9 and Perf 10) is similar to learning and growth perspective by Kaplan and Norton (1996), and the human relations model of effectiveness of 1983. Moreover, the 3 dimensions of performance found here (financial, process, and internal) are also alike different components of diverse Intellectual Capital models. Thus, our valid, reliable scale for measuring performance can also contribute to academics and researches on corporate performance. The structural model supports the direct effects of the production, integration, and application of Knowledge as knowledge management constructs on seep and quality innovation. The effects of production and Integration of knowledge on quality innovation is direct and significant. The application of knowledge effect on quality innovation is directly but not significant. The production, integration and application of knowledge and quality, quantity and speed innovation has direct and significant effects on performance. The results deduced according to the statistics are calculated. The effects of 14 paths are > 1.69 and the effect of one path is < 1.69. Therefore, fourteen hypotheses were supported and verified. Fig. 1. shows the research model.

### 5.3. The test of the hypothesis

Based on the structural equation model results by partial least square method, research hypotheses were supported. For H1, H2 and H3, we found that production, integration, and application of knowledge have a direct and significant effect on speed innovation. The results are as follow:

$$H_1\colon \begin{cases} H0\colon \beta_{K.PRO,I.SPE} \leq 0 \\ H1\colon \beta_{K.PRO,I.SPE} > 0 \end{cases} \Rightarrow \begin{cases} \beta = 0.208 \\ T = 10.516 \end{cases} \quad AND \quad \left| \begin{array}{l} R = 0.513 \\ P = 0.000 \end{array} \right. \tag{H1}$$

$$H_2:\begin{cases}H0:\ \beta_{K.ITE,I.SPE}\le 0\\ H1:\ \beta_{K.INT,I.SPE}>0\end{cases}\Rightarrow\begin{cases}\beta=0.198\\ T=10.123\end{cases}\ AND\ \left|\begin{matrix}R=0.481\\ P=0.000\end{matrix}\right. \tag{H2}$$

$$H_3:\begin{cases}H0:\ \beta_{K.APP,I.SPE}\le 0\\ H1:\ \beta_{K.APP,I.SPE}>0\end{cases}\Rightarrow\begin{cases}\beta=0.178\\ T=8.053\end{cases}\ AND\ \left|\begin{matrix}R=0.440\\ P=0.000\end{matrix}\right. \tag{H3}$$

Based on the above review, T-Values are > 1.96 and 2.58, also Pearson Correlation Values shows $p < 0.05$ and $p < 0.01$. Therefore, hypotheses H1, H2 and H3 were supported. The determination coefficient of model shows that approximately 28% of the speed variations of innovation are justified by the production, integration, and application of knowledge, and 11%, 9%, 8% are allocated to them respectively.

For H4, H5 and H6, we found that the production, integration, and application of knowledge has a direct and significant effect on quality innovation. The results are as follow:

$$H_4:\begin{cases}H0:\ \beta_{K.PRO,I.QAU}\le 0\\ H1:\ \beta_{K.PRO,I.QAU}>0\end{cases}\Rightarrow\begin{cases}\beta=0.515\\ T=7.072\end{cases}\ AND\ \left|\begin{matrix}R=0.654\\ P=0.000\end{matrix}\right. \tag{H4}$$

$$H_5:\begin{cases}H0:\ \beta_{K.ITE,I.QAU}\le 0\\ H1:\ \beta_{K.INT,I.QAU}>0\end{cases}\Rightarrow\begin{cases}\beta=0.126\\ T=2.099\end{cases}\ AND\ \left|\begin{matrix}R=0.556\\ P=0.000\end{matrix}\right. \tag{H5}$$

$$H_6:\begin{cases}H0:\ \beta_{K.APP,I.QAU}\le 0\\ H1:\ \beta_{K.APP,I.QAU}>0\end{cases}\Rightarrow\begin{cases}\beta=0.065\\ T=0.764\end{cases}\ AND\ \left|\begin{matrix}R=0.518\\ P=0.000\end{matrix}\right. \tag{H6}$$

Based on the above review, T-Values for hypothesis H4 is > 1.96 and 2.58. T-Values for hypotheses H5 and H6 are > 1.96. Also Pearson Correlation Values shows $p < 0.05$ and $p < 0.01$. Therefore, hypotheses H4, H5 and H6 were supported. The determination Coefficient of model shows that approximately 44% of the quality variations of innovation are justified by the production, integration, and application of knowledge, and 34%, 7%, 3% are allocated to them respectively.

For H7, H8 and H9, we found that the production, integration, and application of knowledge has a direct and significant effect on quantity innovation. The results are as follow:

$$H_7:\begin{cases}H0:\ \beta_{K.PRO,I.QAUN}\le 0\\ H1:\ \beta_{K.PRO,I.QAUN}>0\end{cases}\Rightarrow\begin{cases}\beta=0.161\\ T=7.645\end{cases}\ AND\ \left|\begin{matrix}R=0.396\\ P=0.000\end{matrix}\right. \tag{H7}$$

$$H_8:\begin{cases}H0:\ \beta_{K.ITE,I.SPE}\le 0\\ H1:\ \beta_{K.INT,I.SPE}>0\end{cases}\Rightarrow\begin{cases}\beta=0.157\\ T=6.846\end{cases}\ AND\ \left|\begin{matrix}R=0.386\\ P=0.000\end{matrix}\right. \tag{H8}$$

$$H_9:\begin{cases}H0:\ \beta_{K.APP,I.QAUN}\le 0\\ H1:\ \beta_{K.APP,I.QAUN}>0\end{cases}\Rightarrow\begin{cases}\beta=0.130\\ T=5.542\end{cases}\ AND\ \left|\begin{matrix}R=0.319\\ P=0.000\end{matrix}\right. \tag{H9}$$

Based on the above review, T-Values are > 1.96 and 2.58 and also Pearson Correlation Values shows $p < 0.05$ and $p < 0.01$. Therefore, hypotheses H7, H8 and H9 were supported. The determination Coefficient of model shows that approximately 17% of the quantity variations of innovation are justified by the production, integration, and application of knowledge, and 6%, 6%, 4% are allocated to them respectively.

For H10, H11 and H12, we found that the production, integration, and application of knowledge has a direct and significant effect on performance. The results are as follow:

$$H_{10}:\begin{cases}H0:\ \beta_{K.PRO,PERF}\le 0\\ H1:\ \beta_{K.PRO,PERF}>0\end{cases}\Rightarrow\begin{cases}\beta=0.187\\ T=23.158\end{cases}\ AND\ \left|\begin{matrix}R=0.705\\ P=0.000\end{matrix}\right. \tag{H10}$$

$$H_{11}:\begin{cases}H0:\ \beta_{K.ITE,PERF}\le 0\\ H1:\ \beta_{K.INT,IPERF}>0\end{cases}\Rightarrow\begin{cases}\beta=0.176\\ T=19.824\end{cases}\ AND\ \left|\begin{matrix}R=0.662\\ P=0.000\end{matrix}\right. \tag{H11}$$

$$H_{12}:\begin{cases}H0:\ \beta_{K.APP,PERF}\le 0\\ H1:\ \beta_{K.APP,PERF}>0\end{cases}\Rightarrow\begin{cases}\beta=0.157\\ T=18.242\end{cases}\ AND\ \left|\begin{matrix}R=0.592\\ P=0.000\end{matrix}\right. \tag{H12}$$

Based on the above review, T-Values are > 1.96 and 2.58 and also Pearson Correlation Values shows $p < 0.05$ and $p < 0.01$. Therefore, hypotheses H10, H11 and H12 were supported. The determination Coefficient of model shows that approximately 64% of the performance variations are justified by the production of knowledge, The Integration of Knowledge, The Application of Knowledge, speed innovation, quality innovation, and quantity innovation. 13%, 12%, 9% are allocated to the production of knowledge, The Integration of Knowledge and The Application of Knowledge respectively.

For H13, H14 and H15, we found that speed innovation, quality innovation and quantity innovation has a direct and significant effect on performance. The results are as follow:

$$H_{13}: \begin{cases} H0: \beta_{I.SPE,PERF} \leq 0 \\ H1: \beta_{I.SPE,PERF} > 0 \end{cases} \Rightarrow \begin{cases} \beta = 0.156 \\ T = 13.471 \end{cases} \quad AND \left| \begin{array}{l} R = 0.586 \\ P = 0.000 \end{array} \right. \tag{H13}$$

$$H_{14}: \begin{cases} H0: \beta_{I.QAU,PERF} \leq 0 \\ H1: \beta_{I.QAU,PERF} > 0 \end{cases} \Rightarrow \begin{cases} \beta = 0.193 \\ T = 23.284 \end{cases} \quad AND \left| \begin{array}{l} R = 0.726 \\ P = 0.000 \end{array} \right. \tag{H14}$$

$$H_{15}: \begin{cases} H0: \beta_{I.QAUN,PERF} \leq 0 \\ H1: \beta_{I.QAUN,PERF} > 0 \end{cases} \Rightarrow \begin{cases} \beta = 0.134 \\ T = 12.519 \end{cases} \quad AND \left| \begin{array}{l} R = 0.503 \\ P = 0.000 \end{array} \right. \tag{H15}$$

Based on the above review, T-Values are > 1.96 and 2.58 and also Pearson Correlation Values shows $p < 0.05$ and $p < 0.01$.Therefore, hypotheses H13, H14 and H15 were supported. The determination Coefficient of model shows that approximately 64% of the performance variations are justified by the production of knowledge, The Integration of Knowledge, The Application of Knowledge, speed innovation, quality innovation and quantity innovation. 9%, 14%, 7% are allocated to speed innovation, quality innovation and quantity innovation respectively.

## 6. Conclusions

This paper represents conclusions relevant to academics and practitioners. Our research finds and explains the dimension of KM that improves organizational innovation and performance. Empirical evidence is provided about the consequences of the production of knowledge, The Integration of Knowledge and The Application of Knowledge on innovation and performance. It also develops previous researches in the field of KM, where with a few empirical support, this link was proposed. Now, academics and companies are aware of the implications and dimensions of KM. Thus, one of the main conclusions of this research is finding KM as a significant mechanism to enhance innovation and performance. Managers can use these findings to negotiate with stakeholders about implementing KM projects. This research can contribute to practitioners, since it provides organizations with new insights and findings that managers can translate into their own companies. By now, firms which implemented KM programs, were unaware of its utility and consequences (Moffett et al., 2002). Now, enterprises can learn about the positive impact of KM and its dimension on innovation and performance. Specifically, companies know that with a clear KM program they can be more innovative, achieve better financial results, improve processes and develop human resources' capabilities. And, in turn, those benefits foster the link of innovation-performance.

This research also has some limitations. First, the sample was obtained from the members of Iranian power syndicate. In this sense, findings may be extrapolated to other areas or countries. Therefore, we cannot provide an international perspective for the above issue. However, in future research, a sampling frame that combines firms from different countries could be used in order to provide a more international perspective to the subject. Also, it may be interesting to analyze companies in different periods of time to observe their advances in KM and the existence of a KM implementation lifecycle. Initially, different KM program are expected over time. Third, subjective measures for performance were included in the questionnaire. In future studies, we will consider objective measures for performance such as intermediate outcomes of KM program (e.g. learning outcomes).

## Appendix A

### *A.1. Production of knowledge (k.pro)*

- External knowledge acquisition:

  Specific staff in my workplace are responsible for obtaining knowledge from external Sources,
  My work output relies on knowledge input externally.
  Experienced staff are recruited externally.

- Internal knowledge acquisition:

  Job rotation is encouraged in my Workplace.
  Experienced staff and staff approaching departure are invited to record their knowledge and experience.
  I learn lessons after project closure.

- Knowledge creation:

  I am encouraged to find alternative solutions for existing assignments in my workplace.
  Work-related suggestions are encouraged in my workplace.
  Existing knowledge is used to develop new knowledge in my workplace.
  I am encouraged to identify best practice for future use.

I am encouraged to analyze success factors to enrich my knowledge.
I am encouraged to analyze mistakes to enrich my knowledge.

### A.2. Integration of Knowledge (k.int)

- Knowledge storage:

Data and information are selected and organized before being stored in my workplace.
Knowledge is recorded by electronic tools (soft copy) in my workplace.
Knowledge is recorded in paper medium (hard copy) in my workplace.
Knowledge resides in human memory (minds) in my workplace.
Knowledge is kept in personal reference file(s).
Knowledge resides in my organization's routines/procedures.
Knowledge is recorded in the form of documentation such as office manuals, work practice, in-house standards, lessons learned, etc.
Confidential/sensitive information has restricted access in my workplace.
Access to some knowledge is recorded.
I know where to find knowledge when I need it.
I know who to ask for knowledge when I need it.

- Knowledge distribution:

Experienced staff in my workplace is encouraged to mentor new or less experienced staff.
Knowledge gained from different projects is made accessible to all in my workplace.
Knowledge is transferred by electronic means throughout the office.
Knowledge is distributed through documentation in my workplace.
Knowledge is shared by daily interaction with colleagues in the workplace, e.g. in the corridor, during lunch, in the pantry, at social functions.
Knowledge is transferred by face-to-face means only.
Staffs who share knowledge receive rewards/recognition in my workplace.
The office layout in my workplace encourages staff to share knowledge.
Knowledge sharing is a measure of employees' performance in my workplace.
Remote access to the workplace's database is provided.
Staff with specific expertise is assigned to specific project(s)

### A.3. Application of Knowledge (k.app)

- Knowledge use:

I utilize knowledge to solve most problems that I encounter in my job.
I am encouraged to apply knowledge/experience learned from previous project(s) to subsequent project(s).
I apply knowledge in developing new products/services.

- Knowledge maintaining:

Specific staff in my workplace are responsible for regular updating of knowledge in the database/library.
Specific staff in my workplace are responsible for maintaining the applicability of the knowledge in the database/library.
I am able to obtain the necessary knowledge when I need it.
A manager/senior staff member is assigned to deal with knowledge needs.
There is a clear policy/strategy in my workplace of how to handle knowledge.

### A.4. Innovation speed (i.spe)

Our organization is quick in coming up with novel ideas as compared to key competitors.
Our organization is quick in new product launching as compared to key competitors.
Our organization is quick in new product development as compared to key competitors.
Our organization is quick in new processes as compared to key competitors.
Our organization is quick in problem solving as compared to key competitors.

### A.5. Innovation quality (i.qua)

Our organization does better in coming up with novel ideas as compared to key competitors.
Our organization does better in new product launching as compared to key competitors.
Our organization does better in new product development as compared to key competitors.
Our organization does better in processes improving as compared to key competitors.
Our organization does better in management improving as compared to key competitors.

### A.6. Innovation quantity (i.quan)

The number of new or improved products and services launched to the market is superior to the average in your industry.
The number of new or improved processes is superior to the average in your industry.

### A.7. Firm performance (perf)

Compared with key competitors, your company.
Firm performance is growing faster.
Firm performance is more profitable.
Firm performance achieves higher customer satisfaction.
Firm performance provides higher quality products.
Firm performance is more efficient in using resources.
Firm performance has internal processes oriented to quality.
Firm performance delivers orders quicker.
Firm performance has more satisfied employees.
Firm performance has more qualified employees.
Firm performance has more creative and innovative employees.

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