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## **How Knowledge Management Implementation Affects the Performance of Egyptian Construction Companies**

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# How Knowledge Management Implementation Affects the Performance of Egyptian Construction Companies

## ABSTRACT

This study examines the effectiveness of knowledge management systems within the construction industry in Egypt from the perspective of knowledge infrastructure capability (KIC), knowledge process capability (KPC) and their impact on business performance (BP) from the financial, consumer, learning and growth, supplier and internal perspectives. The sample consists of 75 first class Egyptian construction companies. The authors used a questionnaire that was modified from the questionnaire previously used by Gold et al., (2001) and Smith (2006). The authors used one-way ANOVA, t-tests and OLS regressions. The results indicated that both knowledge infrastructure capability (KIC) and knowledge process capability (KPC) have a positive effect on business performance (BP). The results also indicate that organizations with well-developed training and development plans have significantly higher KIC and KPC scores compared to those that do not have such plans.

**Keywords:** Egypt; Knowledge Management; Construction Industry; Business Performance; Knowledge Infrastructure Capability; Knowledge Process Capability

## INTRODUCTION

Two of main characteristics of today's business environment are complexity and uncertainty. Most organizations, including construction companies, have a competitive advantage depending on the knowledge available to them. To maintain this competitive advantage in a dynamic environment, companies must keep developing their knowledge management strengths in order to build and improve their knowledge resources over time. Although the term knowledge management is relatively new, the application of knowledge management is not new (Robinson et al., 2004). The main challenge in a knowledge-based economy is to be innovative and to continuously improve products, services and processes (Robinson et al., 2004). Knowledge management is defined as any process of creating, acquiring, capturing, sharing and using knowledge in order to enhance learning and performance in organizations ((Robinson et al., 2004; Scarborough et al., 1999). The goal of the study is to examine the effectiveness of the knowledge management system within Egyptian construction companies from the perspective of Knowledge Infrastructure Capability (KIC) and Knowledge Process Capability (KPC) and its impact on business performance from financial, consumer, learning and growth, supplier and internal perspectives.

The construction industry is a knowledge-driven industry. The main challenge for any construction firm is time and cost of the project. Accordingly, knowledge management when implemented properly will provide employees with necessary knowledge in a fast and reliable method which will likely lead to better business performance when it comes to project cost and time. The construction companies' competitive advantage is directly linked to the effectiveness of their knowledge management system. An effective knowledge management system will encourage individuals within the same organization to create, share and protect knowledge. Mohamed and Anumba (2006) indicated that there is no accepted model when it comes to guiding construction companies in effectively implementing knowledge management. Chen and Mohamed (2005) stated that the number of empirical studies on knowledge management in construction companies worldwide is very limited (Serra et al., 2012).

## Categorizations of Knowledge Management

In the knowledge management literature, the "knowledge" and "information" are two different concepts. Al-Hawamdeh (2002) argued that "information" must be transferred to "knowledge" in order to be shared and transferred. The proposed classification of knowledge management is similar to the classification proposed by Maier (2002). Knowledge management is classified into the following five categories:

1. Ontology of Knowledge and Knowledge Management
2. Knowledge Management Systems
3. Role of Information Technology
4. Managerial and Social Issues
5. Knowledge Measurement

### *Ontology of Knowledge and Knowledge Management*

Moteleb and Woodman (2007) and Kidwell et al., (2000) argued that knowledge begins with “data” which after being processed produces “information” which when mixed with practice becomes “knowledge” that is used in decision making. Nonaka and Takeuchi (1995) identified knowledge management as “the process of applying a systematic approach to the capture, structuring, management, and dissemination of knowledge throughout an organization to work faster, reuse best practice, and reduce costly rework from project to project.” According to the above definition, the linkage between knowledge management and the organizational strategy must ensure that employees are familiar with the knowledge management objectives in order to improve corporate performance.

Polanyi (1967) identified two kinds of knowledge: explicit and tacit. Robinson et al., (2004) defines explicit knowledge as “codifiable knowledge inherent in the so-called non-human storehouses including organizational manuals on processes and procedures, databases, marketing channels and consumer relationship management systems. Explicit knowledge is, therefore, easily shared with other people or parts of an organization. Examples of explicit knowledge in construction are design codes of practice, manuals on construction standards and specifications.” Grant (2007) defines tacit knowledge as “an individual’s judgment and experiences and cannot be articulated or stored.”

### *Knowledge Management Systems*

Nidumolo et al., (2005) identified knowledge management systems as “focusing on grouping the explicit knowledge that exists in organizations, the know-how that can be easily documented and shared.” Alavi and Leidner (2001) indicated that there are three procedures to design a successful knowledge management systems: codification, personalization, and people-finder.

- i- The codification approach, also referred to as the “hard” approach, has as a starting point of bringing together knowledge, store it in powerful databases, using people to document strategy and prepare it to be retrieved by decision makers.
- ii- The personalization approach, also referred to as the “soft” approach, tends to transfer knowledge by using face-to-face interactions. The IT role is limited to connecting people to facilitate tacit knowledge circulation. More investment is made in motivating people who are sharing their knowledge.
- iii- The people-finder approach tends to locate the knowledge location within the organization and not the knowledge itself. Lloria (2008) argued that the people-finder approach facilitates the finding of people who have certain knowledge within the organization as well as to ensure their accessibility to be consulted or to share their knowledge.

Ragab and Aricha (2013) concluded that the knowledge management systems can be grouped into four core categories: “knowledge creation and acquisition, knowledge storage and retrieval, knowledge transfer and sharing, and knowledge application”.

### *Role of Information Technology*

The role of Information Technology (IT) in knowledge management is thoroughly discussed in the knowledge management literature. Lindvall et al., (2003) indicated that there is no comprehensive software for the knowledge management systems. Any software may be used in knowledge acquisition, application and protection.

Grace (2009) argued that the massive growth in the use of the internet will help in managing knowledge management within organizations.

Unfortunately, some organizations started to adopt a full IT-based system for knowledge management based on the unrealistic expectations that this will lead to successful knowledge management. These initiatives did not succeed as it neglected that knowledge management depends on processes accomplished by the human brain with integration of social, cultural and socio-cultural interconnectivity which is neglected by IT. IT-based systems have limited capabilities compared to human brains in knowledge management as they are only focused on explicit knowledge that can be codified and totally neglect the explicit knowledge sources. The second reason for failure of total IT-based systems in knowledge management was the wrong assumption that people, by default, tend to share their knowledge (Lindvall et al., 2003). Mohamed and Anumba (2006) concluded that "IT as a perfect solution will fail. Equally, the knowledge management initiative that undervalues IT will follow suit."

### *Managerial and Social Issues*

Davenport and Prusak (2000) indicated that one of the recurring issues that affects the knowledge management implementation was the resistance of the employees to share knowledge with their counterparts for fear of potential job loss and reducing the probability of being promoted while increasing the probability of their counterparts with whom they share their knowledge being promoted. Unfortunately, in today's organizational systems, knowledge sharing is not rewarded and knowledge hiding is not prohibited. Davenport and Prusak (2000) also stated that "over and above, knowledge exchange may be negatively evaluated as time waste." To solve this conflict, Human Resource Management supports the knowledge management implementation by motivating employees who are sharing their knowledge and engaging them in knowledge management system creation.

Al-Adaileh and Al-Atawi (2011) have argued that organizational culture is essential for the success of knowledge management by supporting knowledge sharing. Kannabiran and Pandyan (2010) indicated that a knowledge management governance system can be formed within the organizational structure and can be led by the organization's Chief Knowledge Officer. Chen and Huang (2007) stated that knowledge sharing increases within decentralized, flat organizations with few hierarchal levels.

Shen and Liu (2003) and Cheng et al., (2000) identified the key factors that lead to knowledge management success as follows: communicating knowledge management benefits to the employees, embedding the knowledge management process in business strategy, developing a system to manage explicit and tacit knowledge, rewarding the sharing of knowledge and at the same time creating a communication methodology within employees, using a suitable IT-based system to support knowledge management and dedicating suitable staff to lead the knowledge management initiatives.

### *Knowledge Measurement*

Bontis (1999) indicated that knowledge measurement is problematic due to the vague nature of knowledge in general and tacit knowledge in specific. Hong Pew et al., (2008) argued that any discussion concerning knowledge measurement must be linked to intellectual capital that is defined as knowledge and experience that can be transformed into assets or competitive advantage for the organization. Kannan and Aulbur (2004) indicated that the concept of intellectual capital can be measured from two perspectives within the organization:

- i- Internal perspective in which the organization is trying to locate the intellectual capital within its employees in order to utilize it more effectively as well as convince top management of its benefits.
- ii- External perspective shows that the organizational book value does not take into consideration the organization's intellectual capital assets and only evaluates its physical assets.

Carson et al., (2004) proposed four knowledge measurement methods: financial, intellectual capital, human capital and performance.

*Financial methods.* There are four financial methods that are used to evaluate an organization's intellectual capital. Tobin's Q method established by James Tobin (1969) which evaluates tangible assets not by their book value but by their replacement cost (Luthy, 1998). Economic Value Added (EVA) developed by Stewart (1994) which applies 164 adjustments to the organization's balance sheet in order to get the intellectual capital value. Human Resource Accounting (HRA) developed by Hermanson (1964) which uses the corporate financial data to evaluate human resource assets. Value Creation Intellectual Coefficient (VAIC) was first introduced by Pulic (2000) and it measures the efficiency of utilization of intellectual capital in order to generate profits for the organization (Hejase et al., 2016).

*Intellectual Capital methods.* The Chartered Institute of Management Accountants (CIMA, 2003) indicated that intellectual capital can be classified into three groups: human, structural and relational (Hejase et al., 2016). Wang, 2011 and Carson et al., (2004) stated that Human Capital (HC) is a combination of skills and abilities that are a major factor in the organization's innovation ability such as the competitive advantage. This type of capital belongs to the employees themselves and is lost upon the employees' departure from the organization. Structural Capital (SC) is represented by the organization's physical resources such as the IT infrastructure used by the employees. Structural capital is not lost upon the employees' departure from the organization.

*Human Capital methods.* The Human Capital view is one of the most realistic and accurate structures of intellectual capital. Norton (2001) proposed the Human Capital Readiness (HCR) model, which used a modified balance scorecard with an emphasis on human capital (Ingham, 2007). Skyrme (2003) stated that the Human Capital Readiness model evaluates five areas in the human capital: "strategic skills and competencies, leadership, culture and strategic awareness, alignment of goals and incentives, and strategic integration and learning." The HR consultants at Watson Wyatt created the Human Capital Index in 2001. They highlighted the impact of HR dimensions on the increase of human capital and it affects the financial value of the organization. The main advantage of this model is its ability to measure the level of the individual's human capital.

*Performance methods.* Carrillo et al., (2003) adopted the view of measuring knowledge by measuring its impact after being implemented. Andreeva and Kianto, (2012) noted that knowledge management implementation is linked to better performance in organizations. Khalifa et al., (2008) argued that the more the employees are using knowledge management systems, the easier it will be for organizations to take corrective actions to fix the issues that are affecting their performance.

Huang et al., (2007) proposed three knowledge management performance methods: quantitative, qualitative and balanced scorecard methods. Quantitative methods use stock price; return on investment and other financial data from the organization's financial statements. Feng et al., (2004) concluded that knowledge management implementation leads stabilizing financial performance while Chang Lee et al., (2005) suggested a relationship between company stock price and the successful implementation of knowledge management. Qualitative methods use surveys and questionnaires to measure performance variation which could be subjective and dependent on individuals' opinions (Kannan and Aulbur, 2004). Balanced Scorecard method, developed by Kaplan and Norton (1996), uses a mixture of financial and non-financial measures. This method is a systematic procedure using indicators of performance to evaluate four categories of performance: financial, internal business processes, consumer, and growth.

### *Business Performance*

Carrillo et al., (2000) concluded an exhaustive survey of construction companies and this led to their proposition that knowledge management has to be combined with the firm's key performance indicators and other performance measures such as balanced scorecard to fulfill the need to evaluate the likely benefits of applying knowledge management. Robinson et al., (2004) introduced the main building blocks for Improving Management Performance through Knowledge Transformation (IMPaKT). The framework is composed of three categories. The first category defines the firm's business goals and strategic objectives. The second and third categories assess the firm's knowledge management process and evaluate the implications and the gaps from the people and product perspectives as well as its impact on business performance.

## **THEORETICAL FRAMEWORK AND RESEARCH DESIGN**

The model that will be used in this study was previously used by Gold et al., (2001). Knowledge Infrastructure Capability consists of three groups: technology, structure of the organization, and culture of the employees (Gold et al., 2001). Knowledge Process Capability has four processes: knowledge acquisition, knowledge conversion, knowledge application and knowledge protection (Gold et al., 2001). When it comes to measuring the organization's performance, Hansen and Oetinger (2001) advocated for using the financial perspective such as, reduction in project cost, sales volume and net profit.

### **Knowledge Infrastructure Capability**

As per Gold et al., (2001), knowledge infrastructure capability has three groups: technology which is the infrastructure (i.e., internet and intranet) that facilitates and integrates knowledge and information and knowledge in the organization. Structure of the organization (i.e., procedures, rules and document management) which can facilitate and promote knowledge sharing. Culture of the employees (i.e., openness, trust and collaboration) which can affect knowledge management by employee interaction, meetings and communication.

#### *Technology*

Becerra-Fernandez (2000) argued that knowledge-based software supports knowledge management. For example, some of the knowledge-based software used in construction companies is for drawings (e.g., AutoCAD), monitoring the project time and budgeting and resource management (e.g., Primavera). The use of internet and emails is essential for day to day activities especially when the project location is geographically far from the company's main office.

#### *Structure of the Organization*

Mintzberg (1979) defined the organizational structure as "ways to divide work into tasks within the organization with the presence of coordination between different departments". Miles and Snow (1978) indicated that the organizational structure filters the information received by the company and specifies what can be learned from this information. Miller (1987) argued that the organizational structure affects information flow as well as employee interaction. Lei and Slocum (1992) and Kanter (1994) proposed that the horizontal organizational form facilitates knowledge transfer within the firm. In construction companies, the project structure represents the information flow within the project. As per Tserng and Li (2004), there are six management stages in construction companies: problem happening, create knowledge, share knowledge, record knowledge, knowledge storage and knowledge reuse (Kanapeckiene et al., 2010).

#### *Culture*

Ajmal and Koskinen (2008) argued that the organizational culture is based on assumptions based on deep beliefs of the organization's participants as well as the demonstration of these beliefs by actions and reactions of the participants. Ajmal and Koskinen, (2008) referred the failure in knowledge transfer to the cultural factors rather than the technological reasons. DeTiene and Jackson (2001) argued that the organizational culture could be a major cause of failure for the knowledge management process. Bedford (2013) stated that the role of individuals could potentially

come into conflict with the company culture. In order to avoid this conflict, Kayworth and Leidner (2003) proposed that sharing knowledge through interpersonal relationships must be encouraged by the organizational culture to ensure successful knowledge creation, storage, transfer and application. Building a supportive organizational culture is vital for a successful knowledge management system.

## **Knowledge Process Capability**

Kayworth and Leidner (2003) suggested that Knowledge Process Capability has four categories. Knowledge acquisition which includes creating and collaborating knowledge. Knowledge conversion which includes organizing, storing, integrating and combining knowledge. Knowledge application which includes retrieving and sharing knowledge. Knowledge protection which includes securing knowledge within the organization.

### *Knowledge Acquisition*

Knowledge acquisition can be considered to have two levels, organizational and individual. Liao et al., (2010) defined knowledge acquisition at the organizational level as “accepting knowledge from outside the organizational environment, transforming it and using it”. Gray and Meister (2004) defined knowledge acquisition at the individual level as the changing of the mental model of the individual by changing their beliefs to the new acquired knowledge with the intention of using this knowledge in order to be effective (Pemsel and Müller, 2012).

### *Knowledge Conversion*

The knowledge conversion is a continuous transformation from tacit to explicit knowledge and vice versa (Nonaka, 1994). According to Nonaka (1994) and Nonaka and Takeuchi (1995), knowledge conversion has four stages: socialization, externalization, combination and internalization. Socialization can be viewed as the conversion of tacit knowledge into other forms of tacit knowledge using social interactions. Externalization can be viewed as the conversion of tacit knowledge to explicit knowledge. Combination can be viewed as the conversion of explicit knowledge into other forms of explicit knowledge using sorting and modeling. Internalization can be viewed as the conversion of explicit knowledge to tacit knowledge within the individual by learning and application.

### *Knowledge Application*

According to Newell et al., (2003) knowledge application is used to enhance the business strategy, solve the problems that arise due to new projects, reduce the cost and the execution time of similar projects by using previous projects' reports, lessons learned and closed out reports. Knowledge transfer is the movement of knowledge to where it can be easily accessed and reused.

### *Knowledge Protection*

Khamseh and Jolly (2008) defined knowledge protection as blocking the knowledge sharing in the knowledge management system. Jennex and Durcikova (2013) defined knowledge protection as preventing the leakage of knowledge to unauthorized external users as well as preventing tacit knowledge loss due to employee turnover. Dhillon and Torkzadeh (2006) argued that organizations rely on information technology systems to secure their knowledge against commercial unauthorized use. Ahmad et al., (2014) stated that poor knowledge protection could cause financial losses for the organization as well as productivity losses.



## **Organization Performance**

The traditional method to measure company performance is from financial perspective such as reduction in project cost, increase in sales volume and increase in net profits. Chakravarthy (1986) found that using financial methods to measure the business performance could give misleading results about the continuity of the company competitive advantage and innovation. Fliaster (2004) suggested using other intangible methods such as, consumer satisfaction perspective, learning and growth perspective, supplier perspective and internal processes perspective. Tseng and Fang, 2015 and Maltz et al., (2003) proposed using financial and non-financial measures such as the following five indexes financial, consumer, process, people development and future.

## **Hypotheses**

**Hypothesis 1:** The knowledge infrastructure capability (KIC) has a positive effect on business performance (BP).

**Hypothesis 2:** The knowledge process capability (KPC) has a positive effect on business performance (BP).

## **DATA COLLECTION**

Following the data collection method used in Perng and Chang (2004), the authors contacted the Egyptian Federation for Construction and Building Contractors, the following data was received as of August 2015: total number of construction companies in Egypt was 10,622 companies. Total number of construction companies classified as First Class (companies allowed to take unlimited integrated projects) was 380 companies. Number of construction companies classified as first class in Cairo, Giza and Alexandria governorates was 299 companies. The authors choose to focus on first class construction companies in Egypt as they are all working within the same culture, same project conditions and same Human Resources mindset.

The questionnaires were distributed to senior managers with 15 years or more of experience in construction who have been working for the past 5 years in the same company. The senior managers included project managers, construction managers, general managers, HR managers and contract managers. The questionnaires were randomly distributed to senior managers in 146 of the 299 first class construction companies in Cairo, Giza and Alexandria governorates. The final sample size was 75 first class construction companies which is about a 51% response rate.

The proposed questionnaire was modified from the one previously used by Gold et al., (2001) and Smith (2006). The proposed questionnaire includes eight sections. The first three sections measure the Knowledge Infrastructure Capability including technology, company structure and culture (Ghosh and Scott, 2009). The following four sections measure Knowledge Process Capability including knowledge acquisition, knowledge conversion, knowledge application and knowledge protection (Emadzade et al., 2012). The last section measures the company performance from the following perspectives: financial, consumer, learning and growth, supplier and internal processes. Responses were presented using a 5-scale Likert scale with a range from 1 (strongly disagree) to 5 (strongly agree). At the beginning of the questionnaire the authors included four questions regarding the organization's legal status, sector, number of employees in 2015 and the availability of a training and development plans. The questionnaire is available in Appendix A.

## **METHODOLOGY AND RESULTS**

### **Descriptive Statistics**

Table 1 shows that 65.3% of the organizations in the sample are partnerships, 29.3% are limited liability, and 5.3% are sole proprietorships. 89.3% are private organizations and 10.7% are public sector organizations. Sixty one point three percent of the organizations in the sample have in excess of 100 employees, 17.3% have between 50 and 99 employees and 21.3% have between 5 and 49 employees. Finally, 78.7% of the organizations have training and development plans.

**Table 1:** Sample Descriptive Statistics

Characteristic	N	%
Organizational legal status		
Limited liability	22	29.3
Partnership	49	65.3
Sole proprietorship	4	5.3
Organization sector		
Private	67	89.3
Public	8	10.7
Organization number of employees in 2015		
5-49	16	21.3
50-99	13	17.3
100+	46	61.3
Organization has training and development plan		
Yes	59	78.7
No	16	21.3

Panel A of Table 2 shows the categorization of the variables that were computed from the survey questions in Appendix A. These variables are KIC (Knowledge Infrastructure Capability), KPC (Knowledge Process Capability) and BP (Business Performance) (Cho and Korte, 2014). Panel B of Table 2 shows the descriptive statistics for these three variables (KIC, KPC and BP). The descriptive statistics for the individual items are provided in Appendix B (Lu, 2014). Panel C of Table 2 shows the results of the normality tests for the three variables. The normality assumption is accepted for all three variables according to the Shapiro-Wilk test. Panel D of Table 2 shows that KIC and KPC are both positively correlated with BP with Pearson's correlation 0.663 and 0.664, respectively.

**Table 2**

**Panel A:** Variables Measured by Questionnaire

Variable Type	Variable Name	Independent Variable Break down	Questionnaire Item Number
Independent	Knowledge Infrastructure Capability	Technology	TI 1,2,3,4
		Structure	SI 1,2,3,4,5,6,7
		Culture	CI 1,2,3,4,5,6

	Knowledge Process Capability	Acquisition	AP 1,2,3,4,5,6
		Conversion	CP 1,2,3,4,5,6
		Application	AP 1,2,3,4,5,6,7
		Protection	PP 1,2,3,4,5,6,7
Dependent	Business Performance	Financial perspective	BP 1,2,3
		Consumer perspective	BP 4,5,6
		Learning & Growth perspective	BP 7,8,9,10
		Supplier perspective	BP 11,12
		Internal processes	BP 13,14

**Panel B:** Descriptive Statistics for KIC, KPC and BP

Variable	N	Mean	SD	Range
KIC score	73	59.92	11.47	32-83
KPC score	74	90.44	18.17	41-130
BP score	72	48.93	9.63	21-70

**Panel C:** Normality Test

	Shapiro-Wilk	
	Statistic	df
KIC score	0.972	75
KPC score	0.987	75
BP score	0.990	75

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001

**Panel D:** Correlation between KIC, KPC and BP

Scale	KIC score	KPC score	BP score
KIC score	1		

KPC score	0.875	1	
BP score	0.663	0.664	1

### Bivariate Analysis

The authors use one-way ANOVA to test for differences in the means between the different categories of organization legal status and organization size. Panel A of Table 3 shows the mean for the three variables KIC, KPC and BP based on the organization's legal status (Trussel and Patrick, 2012). Panel B of Table 3 shows that none of the three types of organization legal status differ in terms of KIC, KPC or BP. Panel C of Table 3 shows the mean for the three variables KIC, KPC and BP based on the organization size (Keung and Shen, 2013). Panel D of Table 3 shows that there are no significant differences between different company sizes in KIC, KPC or BP.

**Table 3**

**Panel A: Averages by Organization Legal Status**

Organization legal status		KIC score	KP score	BP score
Limited liability	Mean	60.86	90.41	49.64
	N	22	22	22
	SD	9.949	15.849	6.630
Partnership	Mean	59.49	90.78	48.57
	N	49	49	49
	SD	12.322	19.651	11.107
Sole proprietorship	Mean	60.00	86.50	49.50
	N	4	4	4
	SD	10.646	13.379	1.000

**Panel B: One-Way ANOVA: Differences across Organizational Legal Status**

Scale	SS	df	F statistic
KIC score			
Between groups	28.68	2	0.106
Within groups	9706.84	72	
KPC score			
Between groups	67.63	2	0.100
Within groups	24348.85	72	
BP score			
Between groups	18.58	2	0.098
Within groups	6848.09	72	

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001

**Panel C: Averages by Organization Size**

Number of employees in 2015	KIC score	KPC score	BP score
-----------------------------	-----------	-----------	----------

5 - 49	Mean	58.63	85.38	49.31
	N	16	16	16
	SD	12.748	18.736	9.090
50 - 99	Mean	62.08	91.69	49.00
	N	13	13	13
	SD	13.357	21.700	10.855
100+	Mean	59.76	91.85	48.78
	N	46	46	46
	SD	10.613	16.982	9.672

**Panel D:** One-Way ANOVA: Differences across Organizational Size

Scale	SS	df	F statistic
KIC score			
Between groups	88.48	2	0.330
Within groups	9647.04	72	
KPC score			
Between groups	522.026	2	0.786
Within groups	23894.45	72	
BP score			
Between groups	3.40	2	0.018
Within groups	6863.26	72	

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001

The authors use t-tests to examine the differences in the means for the organization sector and the availability of training and development plans. Panel A of Table 4 shows there are no statistically significant differences between private and public organizations in any of the three studied dimensions. Panel B of Table 4 shows that organizations having training and development plans will have statistically significant higher KIC, KPC and BP scores than organizations with no training and development plans.

**Table 4**

**Panel A:** T-test: Differences across Organizational Sector

	Organization sector	N	Mean	SD	T statistic	df
KIC score	Private	67	60.03	10.946	0.238	73
	Public	8	59.00	16.125		
KPC score	Private	67	90.91	17.133	0.460	73
	Public	8	86.50	26.468		
BP score	Private	67	49.48	9.809	1.426	73
	Public	8	44.38	6.865		

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001

**Panel B:** T-test: Differences between Organization with Training and Development Plans

	Organization has training and development plan	N	Mean	SD	T statistic	df
KIC score	Yes	59	62.47	10.149	4.076***	73

	No	16	50.50	11.419		
KPC score	Yes	59	92.85	16.623	2.265*	73
	No	16	81.56	21.270		
BP score	Yes	59	50.69	8.889	3.229**	73
	No	16	42.44	9.750		

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001

### Regression Analysis

The authors conducted Ordinary Least Square (OLS) Regressions with BP score as the dependent variable, KIC score as the independent variable in Table 5 (McCall et al., 2008) and KPC score as the independent variable in Table 6 (Good et al., 1997). “Organization has training and development plan” was used as a control variable in Tables 5 and 6. In Table 5 the estimated coefficient of the KIC score is positive and significant as predicted in hypothesis 1 which indicated that there is a positive association between KIC and the company performance.

**Table 5:** OLS Regression Estimates for Hypothesis 1: The knowledge infrastructure capability (KIC) has a positive effect on business performance (BP) (t statistics in brackets)

	BP score
Constant	15.833 (3.513)***
KIC score	0.527 (6.452)***
Organization has training and development plan	1.949 (0.858)
Adjusted R <sup>2</sup>	43%
VIF	1.228
White-Koenker	12.698

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001

In Table 6 the estimated coefficient of the KPC score is positive and significant as predicted in hypothesis 2 which indicated that there is a positive association between KPC and the company performance. The control variable “Organization has training and development plan” is also positive and significant indicating that companies with training and development plans have higher performance compared to companies with no such plans. The variance inflation factors (VIF) in Tables 5 and 6 are less than 10, as result there are no signs of multicollinearity. The White-Koenker statistics given in the last line of the Tables 5 and 6 show that all of our regressions are free of heteroscedasticity (Baum et al., 2003).

**Table 6:** OLS Regression Estimates for Hypothesis 2: The knowledge process capability (KPC) has a positive effect on business performance (BP) (t statistics in brackets)

	BP score
Constant	15.901 (4.204)***
KPC score	0.325 (6.956)***

Organization has training and development plan	4.586 (2.226)*
Adjusted R <sup>2</sup>	46.2%
VIF	1.070
White-Koenker	13.804

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001

## DISCUSSION, IMPLICATIONS AND CONCLUSIONS

The objective of this study was to assess the effectiveness of knowledge management systems within the Egyptian construction industry from the perspective of Knowledge Infrastructure Capability (KIC), Knowledge Process Capability (KPC) and their impact on Business Performance (BP) from financial, consumer, learning and growth, supplier and internal perspectives. Our results indicate that the organizational knowledge management capabilities do affect business performance.

There are statistically significant differences in KIC scores with organizations having training and development plans showing a higher score compared to those that do not have such plan (62.5 vs. 50.5). Organizations having training and development plans also have significantly higher KPC scores compared to those that do not have such plan (92.9 vs. 81.6). Organizations with training and development plans also show significantly higher performance compared to those that do not have such plans (50.7 vs. 42.4). KIC and KPC are both positively correlated with BP with Pearson's correlation 0.663 and 0.664, respectively.

### Implications

Eighty percent of the organizations in our sample claimed to have training and development plans, while the remaining 20% did not have well developed training plans. It is important for top management in the construction industry in Egypt to realize the expected positive effects of implementing well developed training and development plans on business performance. This will hopefully lead Egyptian construction companies to invest more in training and development plans of their employees.

Based on our study's results, it is highly recommended that management encourages knowledge transfer within the same organization. Also the application of a reward system directly related to knowledge exchange between departments may positively affect knowledge management in Egyptian construction companies. The rotation of employees between different departments might lead to a better application of the knowledge management system. Finally, continuous monitoring of knowledge management systems in Egyptian construction companies, as well as, the use of benchmarking with industry leaders is essential for better business performance.

### Future Research

Future research could focus on the effect of employee turnover and its impact on the successful application of knowledge management in Egyptian construction companies. Future studies can focus on small and medium size Egyptian construction companies. These companies are more flexible to change and can be restructured more easily. More examination is required for the barriers to knowledge exchange within organizations which will help give a

realistic corrective action plan for companies planning to maximize their performance by applying knowledge management system.

### **Limitations**

One of the limitations for the study is that the questionnaire respondents may be biased but there are no means for an ideal method for data collection. Another limitation is that the survey participants are answering the questionnaire from their perception, as it was not possible to check the documents of the surveyed companies. Another limitation of the study was the translation of the questionnaires from English to Arabic then back to English. The authors tried to overcome this limitation by using the Werner and Campbell (1970), *decentring method*.

The authors attempt to reduce the selection bias issue (Heckman, 1979) by randomly selecting 146 of the 299 first class construction companies in Cairo, Giza & Alexandria governorates. The sample used construction companies classified as first class according to the Egyptian Federation for Construction & Building Contractors on August 2015 in Cairo, Giza and Alexandria. To include construction companies in other governorates and other classes will be a time consuming and costly process. The problem is that the results of the study cannot be generalized to all construction companies in Egypt.



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## APPENDIX A

The questionnaire was modified from the questionnaire used by Gold et al., (2001) and Smith (2006).

### 1. Demographic questions:

Choose your organization's legal status:

	Choose One
Partnership	<input type="radio"/>
Limited liability	<input type="radio"/>
Sole proprietorship	<input type="radio"/>

### 2. Choose your organization's sector:

	Choose One
Private	<input type="radio"/>
Public	<input type="radio"/>

### 3. Choose your organization's number of employees in 2015:

	Choose One
5 - 49	<input type="radio"/>
50 - 99	<input type="radio"/>
100 +	<input type="radio"/>

### 4. Your organization has training and development plan:

	Choose One
Yes	<input type="radio"/>
No	<input type="radio"/>

## 5. Item Measures of Technological KM Infrastructure

My organization uses technology that allows...

	1.Strongly disagree	2.Disagree	3.Neither agree nor disagree	4.Agree	5.Strongly agree
[TI1]: It to monitor its competition and business partners.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[TI2]: People in multiple locations to learn as a group from a single source or at a single point in time,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[TI3]: People in multiple locations to learn as a group from a multiple source or at multiple points in time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[TI4]: It to map the location (i.e., an individual, specific system, or database) of specific types of knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 6. Item Measures of Structural KM Infrastructure

\*Structure is defined as the rules, policies, procedures, processes, hierarchy of reporting relationships, incentive systems, and departments' boundaries that organize tasks within the firm.

My organization('s)...

	1.Strongly disagree	2.Disagree	3.Neither agree nor disagree	4.Agree	5.Strongly agree
[SI1]:Structure facilitates the discovery of new knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[SI2]:Structure facilitates the creation of new knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[SI3]:Bases our performance on knowledge creation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[SI4]:Has a standardized reward system for sharing knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[SI5]:Designs processes to facilitate knowledge exchange across functional boundaries.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[SI6]:Managers frequently examine knowledge for errors/mistakes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[SI7]:Structure facilitates the transfer of new knowledge across structural boundaries.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 7. Item Measures of Cultural KM Infrastructure

In my organization . . .

	1.Strongly disagree	2.Disagree	3.Neither agree nor disagree	4.Agree	5.Strongly agree
[CI1]:Employees understand the importance of knowledge to corporate success.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[CI2]:High levels of participation are expected in capturing and transferring knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[CI3]:On-the-job training and learning are valued,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[CI4]:Overall organizational vision is clearly stated.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[CI5]:Overall organizational objectives are clearly stated.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[CI6]:Senior management clearly supports the role of knowledge in our firm's success.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 8. Item Measures of KM Acquisition Process

My organization . . .

	1.Strongly disagree	2.Disagree	3.Neither agree nor disagree	4.Agree	5.Strongly agree
[AP1]:Has processes for acquiring knowledge about our customers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP2]:Has processes for generating new knowledge from existing knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP3]:Has processes for acquiring knowledge about our suppliers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP4]:Has processes for distributing knowledge throughout the organization.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP5]:Has processes for acquiring knowledge about new products/services within our industry.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP6]:Has processes for exchanging knowledge between individuals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



### 9. Item Measures of KM Conversion Process

My organization . . .

	1.Strongly disagree	2.Disagree	3.Neither agree nor disagree	4.Agree	5.Strongly agree
[CP1]:Has processes for filtering knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[CP2]:Has processes for transferring organizational knowledge to individuals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[CP3]:Has processes for absorbing knowledge from individuals into the organization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[CP4]:Has processes for integrating different sources and types of knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[CP5]:Has processes for organizing knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[CP6]:Has processes for replacing outdated knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### 10. Item Measures of KM Application Process

My organization . . .

	1.Strongly disagree	2.Disagree	3.Neither agree nor disagree	4.Agree	5.Strongly agree
[AP1]:Has processes for using knowledge in development of new products/ services.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP2]:Has processes for using knowledge to solve new problems.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP3]:Matches sources of knowledge to problems and challenges.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP4]:Uses knowledge to improve efficiency.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP5]:Uses knowledge to adjust strategic direction,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP6]:Is able to locate and apply knowledge to changing competitive conditions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[AP7]:Takes advantage of new knowledge,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### 11. Item Measures of KM Protection Process

My organization . . .

	1.Strongly disagree	2.Disagree	3.Neither agree nor disagree	4.Agree	5.Strongly agree
[PP1]:Has processes to protect knowledge from inappropriate use inside the organization.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[PP2]:Has processes to protect knowledge from inappropriate use outside the organization,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[PP3]:Has processes to protect knowledge from theft from within the organization.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[PP4]:Has processes to protect knowledge from theft from outside the organization.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[PP5]:Has extensive polices and procedures for protecting trade secrets.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[PP6]:Values and protects knowledge embedded in individuals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[PP7]:Clearly communicates the importance of protecting knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 12. Item Measures of Business Performance

In my organization . . .

	1.Strongly disagree	2.Disagree	3.Neither agree nor disagree	4.Agree	5.Strongly agree
<b>Financial perspective:</b>					
[BP1]:Profit growth rate in past year was above industry average in our company.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[BP2]:Return on assets (ROA:how profitable a company is relative to its total assets) in past year was above industry average in our company.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[BP3]:Added value per employee (measure of how well you are 'utilizing' your employees) in past year was above industry average in our company.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Customer perspective:</b>					
[BP4]:We retain existing clients and manage to attract new-ones.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[BP5]:The number of customer complaints within the last period has decreased strongly.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[BP6]:Reputation of our company in eyes of the customers has improved.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Learning and growth perspective:</b>					
[BP7]:The net fluctuation of employees (number of staff replaced due to dissatisfaction with pay, relationships in the workplace and chances for career advances etc – internal reasons) is very low within our company.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[BP8]:Productivity of employees is much higher than industry average.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[BP9]:Employees feel very committed to the organization.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[BP10]:Absenteeism in our company (relative to competition) very low.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Supplier perspective:</b>					
[BP11]:Relationships with key suppliers are excellent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[BP12]:There is a high level of mutual trust among our company and our suppliers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Internal processes perspective:</b>					
[BP13]:We execute business processes far faster than our competitors.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
[BP14]:We execute business processes far cheaper than our competitors.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## APPENDIX B

The questionnaire was modified from the questionnaire used by Gold et al., (2001) and Smith (2006).

### Item measures of Technological KM Infrastructure

Survey Questions	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
<b>My organization uses technology that allows...</b>						
TI1 It to monitor its competition and business partners.	75	1	5	3.92	0.104	0.897
TI2 People in multiple locations to learn as a group from a single source or at a single point in time.	75	1	5	3.56	0.109	0.948
TI3 People in multiple locations to learn as a group from a multiple source or at multiple points in time.	75	2	5	3.61	0.098	0.853
TI4 It to map the location (i.e., an individual, specific system, or database) of specific types of knowledge.	75	1	5	3.51	0.105	0.906

Item Measures of Technological KM Infrastructure My organization uses technology that allows...						
Answer Options	1.Strongly disagree	2.Disagree	3.Neither agree nor	4.Agree	5.Strongly agree	Response Count
[TI1]: It to monitor its competition and business partners.	1	5	12	38	19	75
[TI2]: People in multiple locations to learn as a group from a single source or at a single point in time,	1	9	24	29	12	75
[TI3]: People in multiple locations to learn as a group from a multiple source or at multiple points in time.	0	8	23	34	10	75
[TI4]: It to map the location (i.e., an individual, specific system, or database) of specific types of	2	8	22	36	7	75
<i>answered question</i>						75
<i>skipped question</i>						0

**Item measures of Structural KM Infrastructure**

Survey Questions	N	Minimum		Maximum	Mean		Std. Deviation
	Statistic	Statistic		Statistic	Statistic	Std. Error	Statistic
<b>My organization's ...</b>							
SI1 Structure facilitates the discovery of new knowledge	75	2		5	3.69	0.114	0.986
SI2 Structure facilitates the creation of new knowledge	75	2		5	3.67	0.114	0.991
SI3 Bases our performance on knowledge creation	75	1		5	3.24	0.112	0.970
SI4 Has a standardized reward system for sharing knowledge	75	1		5	2.93	0.132	1.143
SI5 Designs processes to facilitate knowledge exchange across functional boundaries	75	1		5	3.37	0.115	0.997
SI6 Managers frequently examine knowledge for errors/mistakes	75	1		5	3.35	0.118	1.020
SI7 Structure facilitates the transfer of new knowledge across structural boundaries	75	1		5	3.39	0.121	1.051

**Item measures of Cultural KM Infrastructure**

Survey Questions	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
<b>In my organization . . .</b>						
CI1 Employees understand the importance of knowledge to corporate success	75	1	5	3.65	0.111	0.966

CI2 High levels of participation are expected in capturing and transferring knowledge	73	1	5	3.53	0.123	1.055
CI3 On-the-job training and learning are valued	75	1	5	3.68	0.123	1.067
CI4 Overall organizational vision is clearly stated	75	1	5	3.49	0.145	1.256
CI5 Overall organizational objectives are clearly stated	75	1	5	3.71	0.126	1.088
CI6 Senior management clearly supports the role of knowledge in our firm's success	75	1	5	3.71	0.118	1.024

**Item Measures of Cultural KM InfrastructureIn my organization . . .**

Answer Options	1.Strongly disagree	2.Disagree	3.Neither agree nor	4.Agree	5.Strongly agree	Response Count
[CI1]:Employees understand the importance of knowledge to corporate success.	3	5	19	36	12	75
[CI2]:High levels of participation are expected in capturing and transferring knowledge.	4	8	17	33	11	73
[CI3]:On-the-job training and learning are valued,	3	8	16	31	17	75
[CI4]:Overall organizational vision is clearly stated.	6	12	15	23	19	75
[CI5]:Overall organizational objectives are clearly stated.	1	14	10	31	19	75
[CI6]:Senior management clearly supports the role of knowledge in our firm's success.	1	11	14	32	17	75
<i>answered question</i>						75
<i>skipped question</i>						0

<b>KIC Score</b>	<b>75</b>	<b>32</b>	<b>83</b>	<b>59.92</b>	<b>1.324</b>	<b>11.470</b>
<b>Valid N (listwise)</b>	<b>73</b>					

**Item measures of KM acquisition process**

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
<b>My organization . . .</b>						
AP1 Has processes for acquiring knowledge about our consumers	75	1	5	3.55	0.101	0.874

AP2 Has processes for generating new knowledge from existing knowledge	75	2	5	3.40	0.100	0.870
AP3 Has processes for acquiring knowledge about our suppliers	75	1	5	3.61	0.109	0.943
AP4 Has processes for distributing knowledge throughout the organization	75	1	5	3.33	0.119	1.031
AP5 Has processes for acquiring knowledge about new products/services within our industry.	75	1	5	3.60	0.127	1.103
AP6 Has processes for exchanging knowledge between individuals	74	1	5	3.43	0.126	1.086

Item Measures of KM Acquisition ProcessMy organization . . .						
Answer Options	1.Strongly disagree	2.Disagree	3.Neither agree nor	4.Agree	5.Strongly agree	Response Count
[AP1]:Has processes for acquiring knowledge about our customers.	1	8	23	35	8	75
[AP2]:Has processes for generating new knowledge from existing knowledge.	0	14	22	34	5	75
[AP3]:Has processes for acquiring knowledge about our suppliers.	1	9	20	33	12	75
[AP4]:Has processes for distributing knowledge throughout the organization.	1	19	18	28	9	75
[AP5]:Has processes for acquiring knowledge about new products/services within our industry.	3	11	15	30	16	75
[AP6]:Has processes for exchanging knowledge between individuals.	5	10	16	34	9	74
<i>answered question</i>						75
<i>skipped question</i>						0

#### Item measures of KM Conversion process

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
<b>My organization . . .</b>						
CP1 Has processes for filtering knowledge	75	1	5	3.07	0.110	0.949

CP2 Has processes for transferring organizational knowledge to individuals	75	1	5	3.35	0.107	0.923
CP3 Has processes for absorbing knowledge from individuals into the organization	75	1	5	3.36	0.112	0.968
CP4 Has processes for integrating different sources and types of knowledge	75	1	5	3.32	0.116	1.002
CP5 Has processes for organizing knowledge	75	1	5	3.36	0.124	1.074
CP6 Has processes for replacing outdated knowledge	75	1	5	3.28	0.112	0.966

Item Measures of KM Conversion ProcessMy organization ...						
Answer Options	1.Strongly disagree	2.Disagree	3.Neither agree nor	4.Agree	5.Strongly agree	Response Count
[CP1]:Has processes for filtering knowledge.	2	22	23	25	3	75
[CP2]:Has processes for transferring organizational knowledge to individuals.	1	15	21	33	5	75
[CP3]:Has processes for absorbing knowledge from individuals into the organization	2	14	20	33	6	75
[CP4]:Has processes for integrating different sources and types of knowledge.	1	18	20	28	8	75
[CP5]:Has processes for organizing knowledge.	3	16	16	31	9	75
[CP6]:Has processes for replacing outdated knowledge.	2	15	24	28	6	75
<i>answered question</i>						75
<i>skipped question</i>						0

#### Item measures of KM Application Process

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
<b>My organization ...</b>						
APP1 Has processes for using knowledge in development of new products/ services	75	1	5	3.52	0.116	1.005



APP2 Has processes for using knowledge to solve new problems	75	1	5	3.77	0.110	0.953
APP3 Matches sources of knowledge to problems and challenges	75	1	5	3.48	0.121	1.044
APP4 Uses knowledge to improve efficiency	75	1	5	3.67	0.121	1.044
APP5 Uses knowledge to adjust strategic direction	75	1	5	3.64	0.110	0.954
APP6 Is able to locate and apply knowledge to changing competitive conditions	75	1	5	3.52	0.113	0.978
APP7 Takes advantage of new knowledge	75	1	5	3.67	0.111	0.963

Item Measures of KM Application Process My organization . . .						
Answer Options	1.Strongly disagree	2.Disagree	3.Neither agree nor	4.Agree	5.Strongly agree	Response Count
[AP1]:Has processes for using knowledge in development of new products/ services.	2	12	16	35	10	75
[AP2]:Has processes for using knowledge to solve new problems.	1	8	14	36	16	75
[AP3]:Matches sources of knowledge to problems and challenges.	3	11	19	31	11	75
[AP4]:Uses knowledge to improve efficiency.	3	8	15	34	15	75
[AP5]:Uses knowledge to adjust strategic direction,	2	6	22	32	13	75
[AP6]:Is able to locate and apply knowledge to changing competitive conditions.	2	10	20	33	10	75
[AP7]:Takes advantage of new knowledge,	2	9	12	41	11	75
<i>answered question</i>						75
<i>skipped question</i>						0

#### Item measures of KM Protection Process

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
<b>My organization . . .</b>						
PP1 Has processes to protect knowledge from inappropriate use inside the organization	75	1	5	3.59	0.114	0.988

PP2 Has processes to protect knowledge from inappropriate use outside the organization	75	1	5	3.67	0.122	1.057
PP3 Has processes to protect knowledge from theft from within the organization	74	1	5	3.38	0.129	1.107
PP4 Has processes to protect knowledge from theft from outside the organization	75	1	5	3.61	0.118	1.025
PP5 Has extensive policies and procedures for protecting trade secrets	75	1	5	3.51	0.136	1.178
PP6 Values and protects knowledge embedded in individuals	75	1	5	3.43	0.122	1.055
PP7 Clearly communicates the importance of protecting knowledge	75	1	5	3.43	0.129	1.117

Item Measures of KM Protection Process My organization ...						
Answer Options	1.Strongly disagree	2.Disagree	3.Neither agree nor	4.Agree	5.Strongly agree	Response Count
[PP1]:Has processes to protect knowledge from inappropriate use inside the organization.	1	12	16	34	12	75
[PP2]:Has processes to protect knowledge from inappropriate use outside the organization,	3	8	16	32	16	75
[PP3]:Has processes to protect knowledge from theft from within the organization.	3	15	19	25	12	74
[PP4]:Has processes to protect knowledge from theft from outside the organization.	2	11	14	35	13	75
[PP5]:Has extensive polices and procedures for protecting trade secrets.	3	13	22	17	20	75
[PP6]:Values and protects knowledge embedded in individuals.	2	15	18	29	11	75
[PP7]:Clearly communicates the importance of protecting knowledge.	3	13	23	21	15	75
<i>answered question</i>						75
<i>skipped question</i>						0
<b>KPC Score</b>	75	41	130	90.44	2.097	18.165
Valid N (listwise)	74					

#### Item measures of Business Performance

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic

<b>In my organization. .</b>						
<b>Financial perspective:</b>						
BP1 Profit growth rate in past year was above industry average in our company	75	1	5	3.37	0.117	1.010
BP2 Return on assets in past year was above industry average in our company	75	1	5	3.41	0.114	0.988
BP3 Added value per employee in past year was above industry average in our company.	75	1	5	3.21	0.123	1.069
<b>Consumer perspective:</b>						
BP4 We retain existing clients and manage to attract new-ones	75	2	5	4.17	0.097	0.844
BP5 The number of consumer complaints within the last period has decreased strongly	75	1	5	3.61	0.115	0.999
BP6 Reputation of our company in eyes of the consumers has improved	75	1	5	3.84	0.106	0.916
<b>Learning and growth perspective:</b>						
BP7 The net fluctuation of employees is very low within our company.	75	1	5	3.25	0.142	1.231
BP8 Productivity of employees is much higher than industry average	75	1	5	3.07	0.119	1.031
BP9 Employees feel very committed to the organization	74	1	5	3.36	0.128	1.105
BP10 Absenteeism is in our company (relative to competition) very low	74	1	5	3.45	0.116	0.995
<b>Supplier perspective:</b>						
BP11 Relationships with key suppliers are excellent	74	1	5	3.88	0.107	0.921

BP12 There is a high level of mutual trust among our company and our suppliers	74	2	5	3.95	0.092	0.792
<b>Internal processes perspective:</b>						
BP13 We execute business processes far faster than our competitors	75	1	5	3.40	0.119	1.027
BP14 We execute business processes far cheaper than our competitors	75	1	5	3.15	0.112	0.968
<b>OP Score</b>	75	21	70	48.93	1.112	9.633
Valid N (listwise)	72					

Item Measures of Business Performance In my organization ...

Answer Options	1.Strongly disagree	2.Disagree	3.Neither agree nor	4.Agree	5.Strongly agree	Response Count
Financial perspective:[BP1]:Profit growth rate in past year was above industry average in our company.	4	11	19	35	6	75
[BP2]:Return on assets in past year was above industry average in our company.	2	12	23	29	9	75
[BP3]:Added value per employee in past year was above industry average in our company.	5	13	26	23	8	75
Customer perspective:[BP4]:We retain existing clients and manage to attract new-ones.	0	3	12	29	31	75
[BP5]:The number of customer complaints within the last period has decreased strongly.	3	5	24	29	14	75
[BP6]:Reputation of our company in eyes of the customers has improved.	1	6	14	37	17	75
Learning and growth perspective:[BP7]:The net fluctuation of employees is very low within our company.	9	11	18	26	11	75
[BP8]:Productivity of employees is much higher than industry average.	6	13	32	18	6	75
[BP9]:Employees feel very committed to the organization.	4	14	17	29	10	74
[BP10]:Absenteeism is in our company (relative to competition) very low.	3	9	23	30	9	74
Supplier perspective:[BP11]:Relationships with key suppliers are excellent.	2	1	21	30	20	74
[BP12]:There is a high level of mutual trust among our company and our suppliers.	0	4	13	40	17	74
Internal processes perspective:[BP13]:We execute business processes far faster than our competitors.	1	16	21	26	11	75
[BP14]:We execute business processes far cheaper than our competitors.	1	20	28	19	7	75
<b>answered question</b>						<b>75</b>
<b>skipped question</b>						<b>0</b>