

Effect of IT Application on Project Performance Focusing on the Mediating Role of Organizational Innovation, Knowledge Management and Organizational Capabilities

Mahdi Hemmati

Department of Computer Engineering
Iran University of Science and Technology
Tehran, Iran

Hassan Hosseini

Department of Industrial Engineering
K.N. Toosi University of Technology
Tehran, Iran

Abstract—The purpose of this study is to examine the effect of IT application on project performance focusing on mediating role of organizational innovation, knowledge management and organizational capabilities using SEM. For this purpose, 194 managers, supervisors and experts of software developer companies participated in this study. Participants were asked to complete a questionnaire on each subject. SEM was used to analyze data using the LISREL software. Results are thoroughly discussed in this paper and the findings support the role of IT application, organizational innovation, knowledge management and organizational capabilities on project performance and project benefits.

Keywords—information technology; organizational innovation; knowledge management; organizational capabilities; project performance

I. INTRODUCTION

In the past two decades, performance has been the subject of many interesting discussions and has led to theoretical and practical innovations [1]. Project performance is an area of performance evaluation. For improved project implementation, project managers need to identify the factors that affect project performance. Successful project management, along with certain processes, is definitely associated with a successful project and auditing can measure this success. However, one of the main weaknesses of project-based organizations is the lack of proper indicators to audit the project and information technology assets are increasingly used for aid.

Information technology (IT) is as a very broad science involving both hardware and software components as well as network communications between two personal computers to the largest private and public networks [2]. The term IT is used to describe technologies used in capture, storage, processing, retrieval, transmission and reception of information. This term involves recent technologies such as computers, fax transmission, remote communications, and microelectronics as well as older technologies such as document filing systems,

mechanical computing machines, printing and engraving. In other words, IT refers to production of services, issues and factors related to receiving, collecting, storing, processing, retrieving, and managing data and information in computer systems. IT infrastructure, generally defined as the collective application of electronic devices, telecommunications, software, decentralized computer stations, and integrated media, has deeply influenced spatial distance and consequently other systems. IT promotes dynamism, flexibility of services and monetary flows and often provides the opportunity for increased performance and efficiency [3]. Various advances in IT capabilities have quickly transformed the industry over the past decade. Adoption of IT and its efficient implementation can improve the cooperation between supply chain members through fast, accurate information transfer and distribution and application of information systems and finally improve the supply chain efficiency [4].

II. INFORMATION TECHNOLOGY ASPECTS

A. Knowledge Management

With the advent of knowledge-based economy, global economy has been integrated into a single global economy through IT [5], resulting in a massive economic science. In this new situation, firms must continually adapt to the process of change and new economic realities. In this economy, knowledge is the most important factor of production and the most important competitive and strategic advantage of organizations [6]. Therefore, knowledge management is a strategic objective in managing organizational projects [7].

Knowledge management is a strategic effort through which an organization attempts to achieve superiority in competition by using intellectual assets of employees and customers. Obtaining, storing and distributing knowledge will lead employees to work more intelligently, reduce duplication and ultimately provide more innovative products and services which better meet customer needs [8]. The purpose of knowledge management is to identify and pursue collective

knowledge to meet strategic goals and help organizations to compete and survive in the global arena [9]. Although many studies have addressed knowledge management as one of the factors effective in improving organizational performance [10-13], very few studies have focused on the effect of knowledge management on project performance.

B. Organizational Innovation

Innovation is crucial for individuals, institutions, and in total, for all societies because of its relationship with flexibility and performance [14]. Innovation is a continuously planned process which increases competitive advantage of organizations by reducing costs and price of products, increases quality, efficiency and effectiveness of products and services and ultimately increases revenue and publicity of the organization [15]. Innovation refers to value creation of new technology or new business activities in terms of new products or processes [16]. More innovative organizations will be more successful in changing environments by developing new capabilities which allow them to achieve better performance [17]. It is not accidental that innovation is currently noted as the most important factor of sustainable competitiveness [18].

C. Organizational Capabilities

Organizational capabilities refer to the ability of an organization to use assets and capital. In fact, capabilities act as a link between asset and capital and allow these assets to be used profitably by the firm [19]. Capabilities are different from assets, because one cannot give them a monetary value. Capabilities are so deeply integrated in procedures that they are not interchangeable or imitable [20]. Capabilities and processes of an organization are closely tied together, as it is the capabilities of an organization which allows activities required for various processes of the organization to be carried out in an appropriate manner [21]. A review of empirical literature (Table I) suggests that no study has been conducted on the relationship between IT, organizational innovation, knowledge management, organizational capabilities, project performance and project benefits within the framework of structural equation modeling. Therefore, the main problem addressed in this study is the effect of IT application on project performance focusing on the mediating role of organizational innovation, knowledge management and organizational capabilities.

D. Conceptual Model

According to the theoretical literature, the conceptual model is illustrated in Figure 1. Obviously, IT is independent variable; mediating variables include knowledge management, organizational capabilities and organizational innovation. Project performance and project benefits are also dependent variables. Therefore, the hypotheses of the present study are listed as follows:

1. IT application is effective on knowledge management.
2. IT application is effective on organizational capabilities.
3. IT application is effective on organizational innovation.

4. Knowledge management is effective on organizational innovation.
5. Organizational capability is effective on organizational innovation.
6. Knowledge management is effective on project performance.
7. Knowledge management is effective on project benefits.
8. Organizational capability is effective on project performance
9. Organizational capability is effective on project benefits.
10. Organizational innovation is effective on project performance.
11. Organizational innovation is effective on project benefits.

TABLE I. STUDIES CONDUCTED ON THE CURRENT VARIABLES

Reference	Results
[22]	Organizational dynamics is one of the most important mechanisms effective on organizational performance.
[4]	Results showed that IT capabilities had a significantly positive effect on knowledge absorption capacity and performance.
[7]	IT has a positive, significant direct effect on knowledge management. Knowledge management has a significant direct effect on project success. Direct effect of IT was not significant on project success.
[23]	Knowledge management has a direct effect on strategic orientation; however, there are no significant relationships between other variables.
[25]	Results showed that IT can be effective in improving knowledge management.
[24]	Results showed a significant relationship between IT and knowledge management.
[26]	Results showed no significant relationship between ITC infrastructure and knowledge creation.
[27]	Results showed a significant positive relationship between IT components and knowledge management.

III. MATERIALS AND METHODS

This study uses a descriptive (non-trial) methodology using correlation and structural equation modeling; in this study, the relationships between variables are examined through a causal model.

A. Participants

Participants of the current study included managers, supervisors and experts of software developer companies in Tehran, among whom 220 questionnaires were distributed. Out of 203 questionnaires returned, nine questionnaires were excluded due to the high number of questions which were not answered. Finally, 194 questionnaires were included in the analysis.

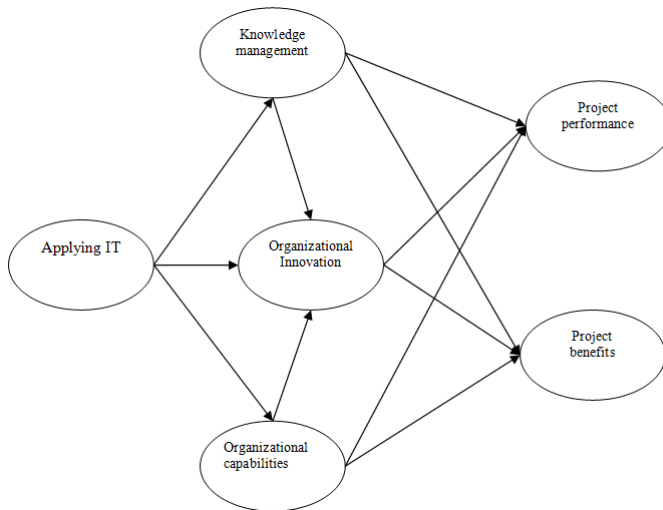


Fig. 1. conceptual model

B. Data Collection Instrument

1) IT application

The questionnaire developed in [7] was used to measure IT application. This questionnaire involves 12 items measuring basic IT tools (4 items) and advanced IT tools (8 items). Questions are scored on a Likert scale from strongly disagree (1) to strongly agree (5). Internal consistency of the questionnaire is estimated at 0.90 using Cronbach's alpha. Moreover, GFI=95, AGFI=0.92 and RMSEA=0.066, indicating that the model is well fitted to data [7].

2) Knowledge management

The questionnaire developed in [7] was used to measure knowledge management. This questionnaire involves 9 items measuring knowledge integration and storage (4 items) and knowledge sharing and application (5 items). Questions are scored on a 5-point Likert scale from strongly disagree (1) to strongly agree (5). Internal consistency of the questionnaire is estimated at 0.88 using Cronbach's alpha. Moreover, GFI=0.93, AGFI=0.90 and RMSEA=0.051, indicating that the model is well fitted to data [7].

3) Organizational innovation

The questionnaire developed in [7] was used to measure organizational innovation. This questionnaire involves 4 questions scored on a Likert scale from strongly disagree (1) to strongly agree (5). Internal consistency of the questionnaire is estimated at 0.84 using Cronbach's alpha. Moreover, GFI=0.98, AGFI=0.96 and RMSEA=0.026, indicating that the model is well fitted to data.

4) Organizational capability

The questionnaire developed in [11] was used to measure organizational capability. This questionnaire involves 7 questions scored on a Likert scale from strongly disagree (1) to strongly agree (5). Internal consistency of the questionnaire is estimated at 0.92 using Cronbach's alpha. Moreover, GFI=95, AGFI=0.94 and RMSEA=0.047, indicating that the model is well fitted to data [11].

5) Project performance

The questionnaire developed in [7] was used to measure project performance. This questionnaire involves 12 items measuring planning performance (3 items), cost performance (3 items), quality performance (3 items) and security performance (3 items). Questions are scored on Likert scale from strongly disagree (1) to strongly agree (5). Internal consistency of the questionnaire is estimated at 0.96 using Cronbach's alpha. Moreover, GFI=0.95, AGFI=0.93 and RMSEA=0.057, indicating that the model is well fitted to data [7].

6) Project benefits

The questionnaire developed by Yang et al (2012) was used to measure project benefits. This questionnaire involves 4 items. Questions are scored on a Likert scale from strongly disagree (1) to strongly agree (5). Internal consistency of the questionnaire is estimated at 0.88 using Cronbach's alpha. Moreover, GFI=96, AGFI=0.94 and RMSEA=0.037, indicating that the model is well fitted to data [7].

C. Data Analysis

By calculating descriptive indexes of the variables, Pearson coefficient of correlation and structural equation modeling (SEM) are used to examine the causal relationships between variables. SPSS and LISREL are used to analyze data.

IV. RESULTS

Matrix of correlation is the cornerstone of analysis of causal relationships. Table II presents the matrix of correlation, mean and standard deviation of the studied variables. According to Table II, there is a significant positive correlation between IT and knowledge management ($r=0.64$), organizational capability ($r=0.46$), organizational innovation ($r=0.46$), project benefits ($r=0.49$) and project performance ($r=0.60$). There is a significant positive correlation between knowledge management and organizational capability ($r=0.44$), organizational innovation ($r=0.40$), project benefits ($r=0.41$) and project performance ($r=0.60$). There is a significant positive correlation between organizational capability and organizational innovation ($r=0.68$), project benefits ($r=0.53$) and project performance ($r=0.55$). There is a significant positive correlation between organizational innovation and project benefits ($r=0.44$) and project performance ($r=0.51$).

Figure 2 shows the fitted model. The numbers on the paths are standardized parameters. According to Figure 2, all path coefficients are significant, except for the path from knowledge management to organizational innovation. Since this study evaluates the mediating role of knowledge management, organizational innovation and organizational capability in the relationship between IT application and project performance and project benefits, Table III lists the coefficients of direct effect, indirect effect, total effect, variance explained and significance level of the variables. As shown in Table II, the direct effect of organizational innovation ($\beta=0.31$), organizational capability ($\beta=0.38$) and knowledge management ($\beta=0.48$) is significant and positive on project performance ($P<0.01$). The direct effect of organizational innovation

($\beta=0.30$), organizational capability ($\beta=0.42$) and knowledge management ($\beta=0.18$) is significant and positive on project performance ($P<0.01$). The direct effect of IT application ($\beta=0.27$) and organizational capability ($\beta=0.51$) is significant and positive on organizational innovation ($P<0.01$). However, the effect of knowledge management is not significant on innovation. Effect of IT application is significant and positive on knowledge management and organizational innovation. The indirect effect of IT application is significant and positive on project performance and project benefits ($P<0.01$). In total, the model explains 47% of variance in project performance, 30% of variance in project benefits, 35% of variance in organizational innovation, 37% of variance in knowledge management and 24% of variance in organizational capabilities. Fit indexes of the path analysis are listed in Table IV. According to Table IV, $\chi^2/df=1.62$, GFI=0.94, AGFI=0.91 and RMSEA=0.057; thus, the fitted model is well fitted.

V. DISCUSSION

This study examines the effect of IT application on project performance focusing on the role of organizational innovation, knowledge management and organizational capabilities using SEM. The results show that the proposed model is well fitted to the data and can explain 47% of variance in project performance and 30% of variance in project benefits. SEM results show that IT application has a positive significant effect on knowledge management. This is consistent with other works

[7, 11, 24, 27]. This finding suggests that the role of IT in knowledge management is important for those organizations which tend to use technologies to manage their intellectual capital. IT influences knowledge management process in different ways as follows: 1) IT facilitates fast knowledge collection, storage and transfer; 2) The advanced information technologies merge discrete knowledge flows, which eliminates the barriers in communication between different parts of the organization; 3) IT improves and develops different methods of knowledge production (socialization, internalization, externalization and combination) and it is not limited to explicit knowledge transfer [28].

TABLE II. MATRIX OF CORRELATION AND DESCRIPTIVE INDEXES OF VARIABLES

Variables	1	2	3	4	5	6
1. IT	1					
2. knowledge management	0.64**	1				
3. organizational capability	0.46**	0.44**	1			
4. organizational innovation	0.46**	0.40**	0.68**	1		
5. project benefits	0.49**	0.41**	0.53**	0.44**	1	
6. project performance	0.60**	0.60**	0.55**	0.51**	0.66**	1
Mean	3.19	2.82	2.91	2.93	3.05	2.89
Standard deviation	0.75	0.80	0.92	0.94	0.93	0.95

** $P<0.01$

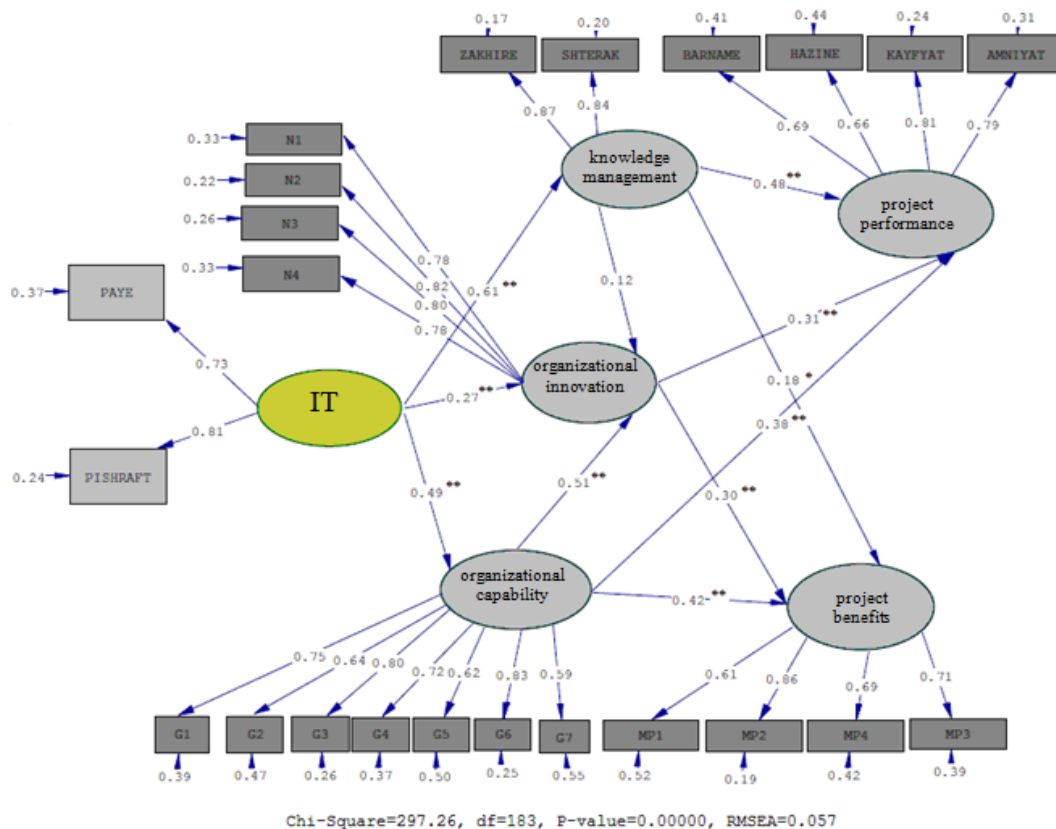


Fig. 2. Fitted model

TABLE III. ESTIMATION OF STANDARDIZED COEFFICIENTS OF DIRECT EFFECT, INDIRECT EFFECT, TOTAL EFFECT AND VARIANCE EXPLAINED OF THE MODEL

Path	Direct effect	Indirect effect	Total effect	Variance explained
Project performance vs				
Organizational innovation	.031**	-	0.31**	47%
Organizational capability	0.38**	0.16**	0.54**	
Knowledge management	0.48**	0.04	0.52**	
Applying IT	-	0.62**	0.62**	
Project benefits vs				
Organizational innovation	0.30**	-	0.30**	30%
Organizational capability	0.42**	0.15**	0.57**	
Knowledge management	0.18*	0.04	0.22**	
Applying IT	-	0.49**	0.49**	
Organizational innovation vs				
Organizational capability	0.51**	-	0.51**	35%
Knowledge management	0.12	-	0.12	
Applying IT	0.27**	0.32**	0.59**	
knowledge management vs				
Applying IT	0.61**	-	0.61**	37%
Organizational capability vs				
Applying IT	0.49**	-	0.49**	24%

** $P < 0.01$; * $P < 0.05$

TABLE IV. FIT INDEXES OF SEM

χ^2/df	RMSEA	GFI	AGFI	CFI	NFI
1.62	0.057	0.94	0.91	0.99	0.98

The results show that IT application has a significant positive effect on organizational capabilities. This finding suggests that IT is a key facilitator of business activities in organizations. Other results show that IT application has a positive significant effect on organizational innovation. This finding suggests that IT application promotes the knowledge and capability of the organization and leads to considerable technological foundations which influence innovation. IT application leads to the tendency for finding the causes of problems and producing best solutions, thus promoting innovation [29]. As shown, knowledge management has no significant effect on organizational innovation but organizational capability has a significant positive effect on organizational innovation. Organizational capability influences organizational innovation by developing abilities, knowledge and organizational strength, whereby it improves project performance.

Knowledge management has a significant positive effect on project performance. This finding is consistent with other works [23, 7, 30] and indicates that knowledge management promotes organizational knowledge and thus enhances the operation of an organization. SEM results show that knowledge management has a significant positive effect on project benefits. This finding is consistent with [7]. In line with this finding, authors in [31] suggested that knowledge management helps different groups to work together, facilitates the exchange of knowledge among them, promotes learning in the organization and improves the ability to fulfill individual and organizational goals, thereby it provides advantages for project success [31]. The results show that organizational capabilities

have a significant positive effect on project performance. This finding is consistent with [22]. Thus, project performance will be promoted if the organization pursues environmental changes to identify the factors effective on the project, evaluates effectiveness of environmental changes on the project, assesses the project to ensure that correct implementation of procedures, make efforts to use new technologies in the project, acquires new knowledge, has better integration capabilities than similar organizations, develops resources ideally, matches business and specialized processes, and has better communication skills and adaptability than similar organizations [24].

The results also show that organizational capabilities have a significant positive effect on project benefits. To explain this finding, one can say that organizational capability refers to the ability of an organization to use assets and capital. In fact, capabilities act as a link between asset and capital and allow these assets to be used profitably by the firm. It is also shown that organizational innovation has a significant positive effect on project performance. This finding suggests that organizational innovation influences project performance by providing financial resources for research and projects and providing new forms of services and new solutions for problem solving. The organization which can provide new ideas and apply them properly is flexible to changes; this organization also can act as a factor of change in its environment.

The results also show that organizational innovation has a significant positive effect on project benefits. This finding suggests that an innovative organization using new technologies can deal with problems, provide new solutions and thus gain advantages for the project success. SEM results also show that knowledge management has a significant positive effect on organizational innovation. This finding is consistent with other works [23, 32, 33].

VI. CONCLUSION

The results presented in this paper show that IT application influences project performance and project benefits through knowledge management, organizational innovation and organizational capabilities. Therefore, knowledge management, organizational innovation and organizational capabilities play a mediating role in the relationship between IT application and project performance. This study addressed a sample of experts and managers of software developer companies; therefore, it is difficult to generalize the results to other contexts and companies. Moreover, findings are based on self-report data. It is recommended to use qualitative research and mixed methods for deeper understanding of the factors effective on project performance.

VII. REFERENCES

- [1] M. Seyed-Taghavi, S. Sepandarand, H. Ramin-Mehr, "Effect of intellectual capitals on organizational performance focusing on mediating role of learning capacity in BSI branches", *Business Management*, Vol. 4, No. 12, pp. 53-70, 2012
- [2] O. Jafari-Hajati, "Evaluation of smart school plan in high schools of Tehran", Master Thesis, Iran, 2006
- [3] E. W. Ngai, D. C. Chau, T. L. A. Chan, "Information technology, operational, and management competencies for supply chain agility:

- Findings from case studies”, *The Journal of Strategic Information Systems*, Vol. 20, No. 3, pp. 232-249, 2011
- [4] H. Liu, W. Ke, K. K. Wei, Z. Hua, “The impact of IT capabilities on firm performance: The mediating roles of absorptive capacity and supply chain agility”, *Decision Support Systems*, Vol. 54, No. 3, pp. 1452-1462, 2013
- [5] M. B. A. Surve, G. Natarajan, Knowledge management tools: recognition for the support to healthcare practitioners”, *International Journal Of Advanced Information And Communication Technology*, Vol. 1, No. 12, pp. 923-927, 2015
- [6] A. Seetherman, H. H. B. Z. Sooria, A. S. Saravanan, “Intellectual Capital Accounting and Reporting in The Knowledge Economy”, *Journal of Intellectual Capital*, Vol. 3, No. 2, pp. 128-148
- [7] L. R. Yang, J. H. Chen, H. W. Wang, “Assessing impacts of information technology on project success through knowledge management practice”, *Automation in Construction*, Vol. 22, pp. 182-191, 2012
- [8] M. Amani, “Comparison of knowledge management process in public and private centers”, 1st Iranian Knowledge Management Conference, Tehran, Iran. 2007
- [9] K. Metaxiotis, K. Ergazakis, “Exploring the world of knowledge management: Agreement and disagreements in the academic practitioner community”, *Journal of Knowledge Management*, Vol. 9, pp. 6-18, 2005
- [10] C. O. Egbu, “Skills, knowledge and competencies for managing construction refurbishment works”, *Construction Management and Economics*, Vol. 17, No. 1, pp. 29-43, 1999
- [11] P. L. Liu, W. C. Chen, C. H. Tsai, “An empirical study on the correlation between knowledge management capability and competitiveness in Taiwan's industries”, *Technovation*, Vol. 24, No. 12, pp. 971-977, 2004
- [12] P. M. Carrillo, H. S. Robinson, C. J. Anumba, N. M. Bouchlaghem, “A knowledge transfer framework: the PFI context”, *Construction Management and Economics*, Vol. 24, No. 10, pp. 1045-1056, 2006
- [13] M. Adenfelt, “Exploring the performance of transnational projects: shared knowledge, coordination and communication”, *International Journal of Project Management*, Vol. 28, No. 6, pp. 529-538, 2010
- [14] R. F. Runco, “Perception of learning culture, concerns about the innovation and their influence on use of on-going innovation in the Malaysian public sector”, PhD dissertation, University of Georgia. 2004
- [15] B. Kerr, C. Gagliardi, “Measuring creativity in research and practice” in “Positive psychological assessment: A handbook of models and measures”, American Psychological Association, 2003
- [16] S. Wong, “Organizational Innovation Management: An organizational-wide perspective”, *Industrial management & Data Systems*, Vol. 107, No. 9, pp. 1290-1315, 2007
- [17] F. J. Montes, A. Ruiz Moreno, L. Miguel Molina Fernández, “Assessing the organizational climate and contractual relationship for perceptions of support for innovation”, *International Journal of Manpower*, Vol. 25, No. 2, pp. 167-180, 2004
- [18] Y. Chen, Y. Wang, S. Nevo, J. Benitez-Amado, G. Kou, “IT capabilities and product innovation performance: The roles of corporate entrepreneurship and competitive intensity”, *Information & Management*, Vol. 52, No. 6, pp. 643-657, 2015
- [19] Y. V. Lun, K. C. Shang, K. H. Lai, T. C. E. Cheng, “Examining the influence of organizational capability in innovative business operations and the mediation of profitability on customer satisfaction: An application in intermodal transport operators in Taiwan”, *International Journal of Production Economics*, Vol. 171, pp. 179-188, 2016
- [20] J. J. Lee, H. Yoon, “A comparative study of technological learning and organizational capability development in complex products systems: Distinctive paths of three latecomers in military aircraft industry”, *Research Policy*, Vol. 44, No. 7, pp. 1296-1313, 2015
- [21] R. M. Grant, G. Verona, “What’s holding back empirical research into organizational capabilities? Remedies for common problems”, *Strategic Organization*, Vol. 13, No. 1, pp. 61-74, 2015
- [22] S. M. Tseng, P. S. Lee, “The effect of knowledge management capability and dynamic capability on organizational performance” *Journal of Enterprise Information Management*, Vol. 27, No. 2, pp. 158-179, 2014
- [23] A. A. Ferraresi, C. O. Quandt, S. A. Dos Santos, J. R. Frega, “Knowledge management and strategic orientation: leveraging innovativeness and performance”, *Journal of Knowledge Management*, Vol. 16, No. 5, pp. 688-71, 2012
- [24] S. M. Tseng, “The effects of information technology on knowledge management systems”, *Expert Systems with Applications*, Vol. 35, pp. 150-160, 2008
- [25] C. J. Neels, D. Johnson, “Information management as an enabler of knowledge management maturity: a south African perspective”. *International Journal of Information Management*. Vol. 30, pp. 57-67, 2010
- [26] M. Goudarzi, M. Abutorabi, “The relationship between ITC and knowledge management”, 1st National Sport Management Conference, Amol, Iran, 2008
- [27] Y. Sobhani, H. Honari, J. Shahlaei, A. Ahmadi, “The relationship between IT and knowledge management”, *Sports Management*, Vol. 17, pp. 55-73, 2013
- [28] N. Yaghoubi, R. Kuchakzade, “IT support of knowledge management”, *Industrial Management Studies*, Vol. 9, pp. 41-56, 2005
- [29] N. Venkatraman, “The concept of fit in strategy research: Toward verbal and statistical correspondence”, *Academy of Management Review*, Vol. 14, No. 3, pp. 423-444, 1989
- [30] Y. Liu, L. Wang, C. Yuan, Y. Li, “Information communication, organizational capability and new product development: an empirical study of Chinese firms”, *The Journal of Technology Transfer*, Vol. 37, No. 4, pp. 416-432, 2012
- [31] J. H. Dyer, K. Nobeoka, “Creating and managing a high-performance knowledge-sharing network: the Toyota case”, *Strategic Management Journal*, Vol. 21, No. 3, pp. 345-367, 2000
- [32] J. Darroch, “Knowledge management, innovation, and firm performance”, *Journal of Knowledge Management*, Vol. 9, No. 3, pp. 101-115, 2005
- [33] S. H. Liao, C. C. Wu, “System perspective of knowledge management, organizational learning, and organizational innovation”, *Expert Systems with Applications*, Vol. 37, No. 2, pp. 1096-1103, 2010