

The Relationship between Intellectual Capital and Project Managers Competencies by Using Structural Equation: CFA

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Abstract: *This study was aimed at developing a method for measuring the relationship between intellectual capital and project manager competencies. Intellectual capital consist human capital, structural capital and relational capital. Project manager competencies have been evaluated based on IPMA Competence Baseline (ICB) and Project Manager Competency Development Framework (PMCDF) includes knowledge, skill, personality, and industry & organization competence. In this study, the relationship between intellectual capital and project manager competencies were investigated and a weak, yet negative correlation was observed as an outcome of this quantitative study. The results are significant because of the method is used. In addition, the study results are so stable and reliable because we use confident instrument to measure indicators.*

Keywords: *Intellectual Capital; Project Managers Competencies; Human Capital; Structural Capital and relational capital.*

Introduction

The optimum situation for a project organization is that all the people, the project team and resource providers involved in project management are competent to carry out their work and to take individual responsibility (ICB-IPMA, 2003). No one would claim that every project that fails is the result of poor management. A poorly funded or ill-conceived project will fail regardless of the skills of the project manager or project team. But project mismanagement plays a significant role in many project failures (Mark Gould and Rick Freeman, 2004). Competency is an observable set of skills, knowledge, abilities, and other characteristics an individual needs to successfully perform work duties or occupational functions (National park service U.S department of the interior, 2010). By aligning competencies to business strategies, organizations can better recruit and select employees for their organizations (Mulder, M., 2001). It is important to choose the right people to manage projects (Mark Gould and Rick Freeman, 2004). Competencies are identified and demonstrated through sets of behaviors that encompass the skills, knowledge, abilities and personal attributes that are critical to successful role accomplishment (Scottish Community Development Centre, 2007). Human capital is the stock of competencies, knowledge, social and personality attributes, including creativity, cognitive abilities, embodied in the ability to perform labor so as to produce economic value (Simkovic, 2013). Of course, one of the most important intangible assets of these companies is the human capital; in other words, employees! Perhaps if we required the listing of human capital on the balance sheet as an asset and not just a liability, we could begin to properly identify the value of human capital to these companies themselves (Weatherly, L., 2003).

Sveiby (1998) highlighted in his definition of intellectual capital two basic aspects; one that is human-specific, reflected in the knowledge, experiences, and brainpower of employees, and another one that is organization-specific, reflected in the know ledge resources stored in an organization's databases, processes, culture and philosophy (Suha Sameer Al-Khalil, 2014). According to Roos, Pike and Fernstrom (2005) "Intellectual Capital can be define as all nonmonetary and nonphysical resources that are fully or partly controlled by the organization and that contribute to the organization's value creation" (G. Roos, S. Pike, L. Fernstrom, 2005). It is the collection of intangible and knowledge-based assets a company (or individual) possesses. Components of intellectual capital include human capital, relationship capital and structural capital (Marr, 2013, G. Roos, S. Pike, L. Fernstrom,

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2005). Intellectual capital helps to drive success and create value. The success of leading companies such as Amazon, Google, Microsoft, and Wal-Mart is based on their intellectual capital (Marr, 2008).

Research Model

Intellectual Capital

Intellectual capital means gathering all the organization members' intellect and their usage [16]. Stewart (1997) defined intellectual capital as a complex of useful knowledge that includes an organization's processes, technologies, patents, employees' skills, and information about customers, suppliers and stakeholders (Stewart, T., 1997). As such, it is concluded that the collection of an organization's knowledge-based (intangible) resources and their flows, and the conversion of the resulting knowledge into competitive advantage, value, and profit, are what form the core of an organization's intellectual capital (Harrison & Sullivan, 2000; Bontis, 2001; Wang & Chang, 2005). Intellectual capital factors: (Ramezan Jahanian, 2013)

- Human capital
- Structural capital
- Relationship capital (Customer)

Human Capital

The first definitions of Human Capital (Mincer, 1958; Schultz, 1961; Johnson, 1960; Marshall, 1961, p. 788; Lev e Schwartz, 1961, 1971) came from the Fisher's capital definition (1930). Human Capital refers to the combination of factors held by individuals and by a company's workforce. It may comprise knowledge, ability and technical skills; personal features such as wit, energy, attitude, confidence, commitment, learning ability; it includes aptitude, imagination and creativity; to be willing to share information, make part of a team and focus on organization goals (Fitz-enz, 2000).

Structural Capital

Structural capital covers a number of different notions related to the company rather than to the specific employee. Structural capital is divided into organizational capital (innovation and process capital) and customer capital (Edvinsson and Malone, 1997) Structural capital is the knowledge embodied in the organization, in the structures built to support the staff in their intellectual work. It helps the organization in turning individual human intelligence into knowledge that can be measured and developed on an organizational level. Without good and reliable structures for leveraging human capital it will only remain in the minds of the employees (Ordóñez de Pablos 2004, Bontis 1998)

Relationship Capital (Customer)

Relationship capital should be seen as part of the firm's structural capital. The way, in which relationship structural capital is defined, however, focuses on relationships with "customers, suppliers, alliance partner, shareholders and other stakeholders" (Roos et al., 1997:43). I.e., in their view relationship capital corresponds to interorganizational relationships. Relational capital consists of a wide variety of external relationships between the organization and its customers, suppliers, competitors, and partners. Suggested measurements of relational capital include seeing it as a function of the longevity of the relationship, based on the assumption that the value of relational capital increases with time (Bontis 1998). Components of intellectual capital in this study is in accordance with Table 1.

Table (1): Components of intellectual capital

Factors	Components	Method of Evaluation
Human Capital	<ul style="list-style-type: none"> ▪ Empowerment (competence, a sense of the work). ▪ Recruitment ▪ Education ▪ Evaluation of human ▪ Ability to communicate 	<ul style="list-style-type: none"> ▪ Evaluation of human resource ▪ Comments by respondents <p>* All of the above were asked employees in form of questionnaire</p>
Structural Capital	<ul style="list-style-type: none"> ▪ Innovation ▪ Team work ▪ Structure ▪ Process ▪ Access to information ▪ Leadership ▪ Hierarchy ▪ Culture 	<ul style="list-style-type: none"> ▪ Training and personal research include : <ol style="list-style-type: none"> 1. Number of educational Classes 2. Classes influence on employees' skills and abilities 3. Personnel ability to problem solving effectively in different projects, including research and development. (Based on the number of items provided) 4. Approved budgets for the organizational research <p>* All of the above were asked employees in form of questionnaire</p>
Relationship capital (Customer)	<ul style="list-style-type: none"> ▪ Customer satisfaction ▪ Good vision of the organization with other people & other organizations. 	<ul style="list-style-type: none"> ▪ Comments by respondents asked employees in form of questionnaire

Project managers' competencies

Competence is a term which is widely used but which has come to mean different things to different people. It is generally accepted, however, as encompassing knowledge, skills, attitudes and behaviors that are causally related to superior job performance (Boyatzis 1982). To understand competency requirements of a job role, they are often represented pictorially and competencies are mapped, with competencies existing on a hierarchy (Sandwith, 1993). Simply stated, a competency model is a behavioral job description that must be defined by each occupational function and each job (Fogg, 1999). Depending on the work and organizational environment, a group of 7 to 9 total competencies are usually required of a particular job and depicted in a competency model (Shipman, et. al., 2000). Rothwell (2002) explains that there are core competencies that are required of all workers. This would include knowledge, skills and abilities (commonly referred to asKSAs), as well as soft skills or behaviors (Michelle R. Ennis , 2008).Project management competencies require knowledge and experience in the subject, which enables the project to meet its deadlines and objectives (Gareis and Huemann, 1999).

In this research, PMCDF (Project Manager Competency Development Framework) and PMBOK (Project Management Body of Knowledge) standards and IPMA competence baseline were considered as main models, but only structure and elements of the PMCDF standard is adapted to the research because it is not classified to the different classification of the projects. Also beyond PMBOK standard, the three areas of change management, difficulties & barriers project management and metrics management are created. The PMCD Framework identifies competencies in five dimensions—Knowledge, Performance and Personal. (Rebecca Ann Winston, 2002). Demonstrate project management proficiency in three dimensions (Ibid, 2002):

- ✓ Knowledge– what a project manager knows about the application of processes, tools, and techniques in project activities.
- ✓ Performance –how a project manager applies project management knowledge to meet project requirements.
- ✓ Personal –how a project manager behaves when performing activities in a project environment.

- ✓ Industrial & Organizational - are considered as the Contextual Competence range to describe the project management competence elements related to the context of the project. This range covers the project manager's competence in managing relations with the line management organization and the ability to function in a project focused organization. The ICB contains 11 contextual competence elements like; project orientation, business, finance, legal, health, safety, security & environment, system, products & technology and so on.

Hypothesis Development

Project management as the most important process in project-based organizations cannot develop without any care to other factors in the organization. Project Manager Competency Model develops necessary parameters like knowledge, skills, personal characteristics' project managers and important processes of project management. It is useful to develop it appropriately as a basis for the organization's intellectual capital. The project management as a core process in the project-oriented organizations is related to structural capital, relational capital and human capital of the organization. Human-embodied knowledge, which takes the forms of skills, experiences, competencies, talents, creativity, amongst others, make up an organization's human capital (Stewart, 1997; Roos, 1998; Van Buren, 1999; Katila & Ahuja, 2002; Subramaniam & Youndt, 2005; Seleim & Khalil, 2011), and is considered the source, from which ideas and solutions that can enhance existing products, services, and processes in projects and develop project management process.

Structural capital, which reflects organizational knowledge in the forms of technologies, patents, manuals, processes, and culture that are so important to project management process. A project organization is a structure that facilitates the coordination and implementation of project activities. Its main reason is to create an environment that fosters interactions among the team members with a minimum amount of disruptions, overlaps and conflict. One of the important decisions of project management is the form of organizational structure that will be used for the project. The structure defines the relationships among members of the project management and the relationships with the external environment (Paola L. Diaz, 2007). Without good and reliable structures for leveraging human capital it will only remain in the minds of the employees. In other words, by leveraging human capital and making it useful for the whole organization, the employees create structural capital (Ordóñez de Pablos 2004, Bontis 1998).

The aforementioned discussion leads to our research hypothesis:

- ❖ There is a positive and significant relationship between intellectual capital (human, structural, and relational) and project manager's competency model (knowledge, performance, personal, Industrial and Organizational Competencies).

Research Methodology

The research followed a survey design where the structured and unstructured exams were used to evaluate the competencies of project managers. Also, it followed a survey design in which has been used structured and unstructured questionnaires to evaluate the dimensions' characteristics of intellectual capital. The research population consisted of all seven energy research institutes operating in Iran. All of seven energy research institutes invited to participate in research survey. Six out of seven energy research institutes agreed to participate, which represented 90.0% of the whole population and the unit of analysis consisted of project managers. The population who participated in survey is about two hundred persons. Based on total population, the response rate was 95.0% which is considered a very high one (Dillman, 1978; Hair, Anderson, Tatham, & Black, 1998). Measurement of the research constructs have been shown in table4.

Analysis and Result

Validity and Reliability

Validity indicates the extent to which one or a set of criteria to explain the concept of the study as well. The statistical method for assessing the validity, factor analysis is a statistical summary table2 of the index test and confirmatory factor analysis of the main components of the research presented.

Table (2): Confirmatory factor analysis of statistical indicators (validity) of the main components of the research

The test statistic	Intellectual Capital Dimension		Competency Dimension	
	Optimal parameters	The external dimension of the model	Optimal parameters	The external dimension of the model
Area covered by the chi-square with degrees of freedom	$\frac{\chi^2}{d.f} \dots > 11.943$	$\frac{\chi^2}{d.f} \dots > 0$	$\frac{\chi^2}{d.f} \dots > 4.414$	$\frac{\chi^2}{d.f} \dots > 0$
Goodness of fit index	GFI=1.47	GFI>0.9	GFI=0.95	GFI>0.9
The root mean square error of the estimate	RMSEA=0.023	RMSEA<0.05	RMSEA=0.046	RMSEA<0.05
Adjusted goodness of fit index	AGFI=0.24	0<AGFI<1	AGFI=0.50	0<AGFI<1
Not a normal fit index	NNFI=0.98	NNFI>0.9	NNFI=1.35	NNFI>0.9
The comparative fit index	CFI=0.90	CFI>0.9	CFI=0.98	CFI>0.9

The reliability of constructs was measured by calculating Cronbach’s alpha coefficient for the factors that resulted from EFA. The closer the value of Cronbach’s alpha is to one, the higher the degree of internal consistency among items (Hair et al., 1998; Field, 2000). Table 3 shows all constructs were highly reliable, ranging from 0.830 to 0.965.

Table (3): Reliability of research constructs

Construct	Number of items	Cronbach's alpha
Knowledge Competency	12	0.965
Performance Competency	12	0.952
Personal Competency	6	0.854
Organizational Competency	10	0.933
Industrial Competency	3	0.837
Human Capital	5	0.897
Structural Capital	8	0.890
Relationship Capital	2	0.830

Descriptive analysis and correlation

Pearson correlation test determine the relationships between project managers' competencies and intellectual capital. Competency test results show that the project manager's competencies characteristics are not desired. Proportion test are used to investigate this hypothesis by comparing scores of administrators competency model components. In this test, the null hypothesis and alternative hypothesis are as follows:

- Null hypothesis: the characteristics of project manager's competencies are not in good condition. (More than half of project managers competencies based on component scores have not achieved a satisfactory score.)
- Alternative hypothesis the characteristics of project manager's competencies are in good condition. (More than half of project managers competencies based on component scores are getting a good score.)

Table (4): Measurement of the research constructs.

Project Manager Competency Model					
Dimensions	Knowledge	Performance	Personal	Organizational	Industrial
	1. Basic knowledge of project management	1. Scope Management		1. Legal topics	
	2. Project Definition	2. Time Management		2. Organizational knowledge	
	3. Create project schedules and costs	3. Cost Management		3. Familiarity with technology and research	1. Familiarity with electricity and energy industry
	4. Project Schedule and Cost Management	4. Quality Management		4. Familiarity with the characteristics of research projects	2. Familiarity with the Ministry of Energy and related industries
	5. Issue management	5. Human Resource Management	1. Communication	5. HSE Management	
	6. Change Management	6. Communication Management	2. Leadership	6. Benchmarking and comparative studies	3. Familiarity with technology, products and services to the power industry
	7. Communication Management	7. Risk Management	3. Management	7. Knowledge management	
	8. Risk Management	8. Procurement Management	4. Cognitive skills	8. Proficiency in English	
	9. Human Resource Management	9. Change Management	5. Be effective	9. Computer skills	
	10. Project Quality Management	10. Issue Management	6. Being a professional	10. Quality of education	
	11. Measures and Metrics Management	11. Metric Management			
	12. Procurement Management	12. Basic knowledge of project management			
References & The measuring	PMCDF model, PMI (2007). Method of evaluation: Exam; 105 questions multiple-choice test method's of TenStep company	PMCDF model, PMI (2007). Method of evaluation: Exam; 36 questions with the correct descriptive project management expertise consensus of experts	PMCDF model, PMI (2007). Method of evaluation: Exam; 25 questions personality using DISC, test - multiple choice	Opinions of experts using the Delphi technique (2014). Method of evaluation: Exam; 20 questions for organizational competency and 8 questions for industrial competency in manner of multiple choice test.	
Intellectual Capital					
Dimensions	Human Capital	Structural Capital		Relationship Capital	
	1. Empowerment (competence, a	1. Innovation	2. Team work	1. Customer satisfaction	2. Good vision of the organization with other
		3. Structure			

	sense of the work). 2. Recruitment 3. Education 4. Evaluation of human Resources 5. Ability to communicate	4. Process 5. Access to information 6. Leadership 7. Hierarchy 8. Culture	people & other organizations.
References & The measuring	Evaluation of human resource - Comments by respondents -* All of the above were asked employees in form of questionnaire	- Training and personal research include : 1 - Number of educational Classes 2 - Classes influence on employees' skills and abilities 3 - Personnel ability to problem solving effectively in different projects, including research and development. (Based on the number of items provided) 4 - Approved budgets for the organizational research * All of the above were asked employees in form of questionnaire	- Comments by respondents -asked employees in form of questionnaire

As shown in table 5, since the levels of significance (p-value) of all components is less than the critical value (0.05), therefore, not supported by the null hypothesis and suggests that the current situation is not satisfactory in the community project managers deserve. The extent of this gap is more in the knowledge of the skills and personal competencies.

Table (5-1, 5-2): Project Managers Competency Characteristics (One-Sample Statistics)

<i>Table (5-1)</i>	N	Mean	Std. Deviation	Std. Error Mean
industrial	200	6.4837	.77141	.05455
organizational	200	6.5149	1.38556	.09797
individual	200	6.4444	.70431	.04980
skill	200	5.9349	.87971	.06220
knowledge	200	5.2660	1.08386	.07664
competency	200	6.1283	.54201	.03833

<i>Table (5-2)</i>	Test Value = 7					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
industrial	-9.465	199	.000	-.51630	-.6239	-.4087
organizational	-4.952	199	.000	-.48515	-.6783	-.2920
individual	-11.156	199	.000	-.55560	-.6538	-.4574
skill	-17.123	199	.000	-1.06515	-1.1878	-.9425
knowledge	-22.625	199	.000	-1.73400	-1.8851	-1.5829
competency	-22.744	199	.000	-.87170	-.9473	-.7961

As shown in table 5-2, since the levels of significance (p-value) of all components is less than the critical value (0.05), therefore, not supported by the null hypothesis and suggests that the current situation is not satisfactory in the intellectual capital. The extent of this gap is more in relational capital.

- Null hypothesis: the intellectual capital of the samples is not desirable. (More than half of managers have not achieved a satisfactory score based on scores in intellectual capital components.)
- Alternative hypothesis: the intellectual capital of the samples is desirable. (More than half of managers have achieved a satisfactory score based on scores in intellectual capital components.)

Table (6): Intellectual capital Characteristics at Project Oriented Research Institutes (One-Sample Test)

	N	Mean	Std. Deviation	Std. Error Mean
Human	200	4.9818	1.55233	.10977
structural	200	4.3764	1.22549	.08666
customer	200	3.8500	1.20111	.08493
MC	200	4.4027	1.27836	.09039

	Test Value = 7					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Human	-18.386	199	.000	-2.01818	-2.2346	-1.8017
structural	-30.276	199	.000	-2.62357	-2.7945	-2.4527
customer	-37.089	199	.000	-3.15000	-3.3175	-2.9825
MC	-28.733	199	.000	-2.59725	-2.7755	-2.4190

Hypothesis testing

The research main hypothesis was tested by regressing project managers' competency model and intellectual capital, using multiple regression analysis. The Pearson's, Spearman's and Kendall's correlation coefficient are shown in Table 8. Amount of P-value at all correlation coefficient is more than 0.05 and it means there is no direct correlation between project managers' competencies and intellectual capital in the project oriented research institutes.

Table (7): The correlation coefficient between components of project managers' competencies and intellectual capital

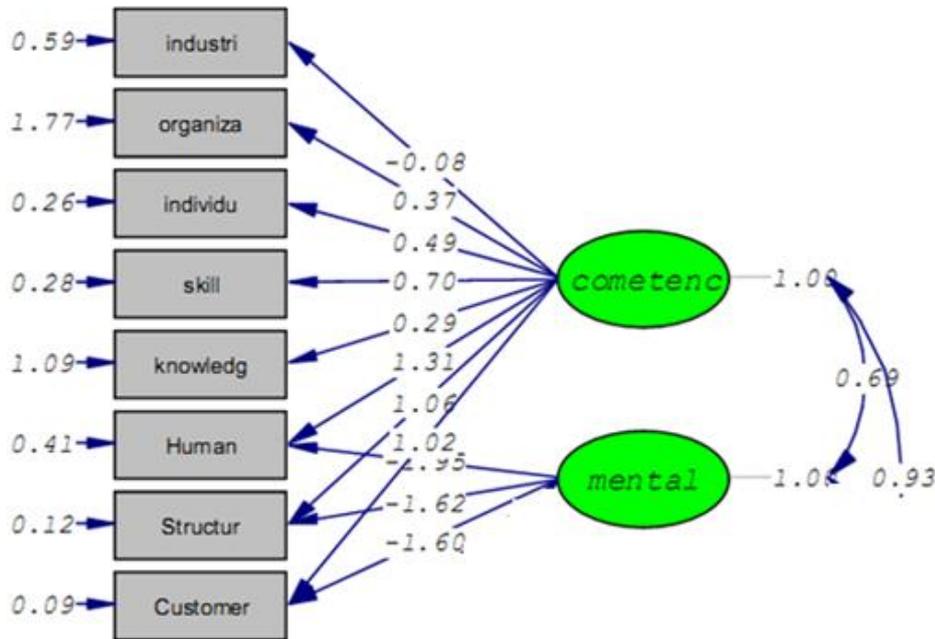
Components' Relationships		The correlation coefficient	P-value
(KC) & (IC)	Pearson's correlation coefficient	-0.028	0.696
(PC) & (IC)	Pearson's correlation coefficient	-0.070	0.325
(PerC) & (IC)	Pearson's correlation coefficient	-0.009	0.904
(InC) & (IC)	Pearson's correlation coefficient	-0.104	0.141
(OC) & (IC)	Pearson's correlation coefficient	-0.143	0.043

The following represents the portion of the model is appropriate fitness. The standard parameter values for each of the Figure 1 indicate their loadings on the latent variable have the value $2 > t$ corresponding in Figure 2 a significant contribution lies in showing the measured variable.

Table (8): Fitness index component model

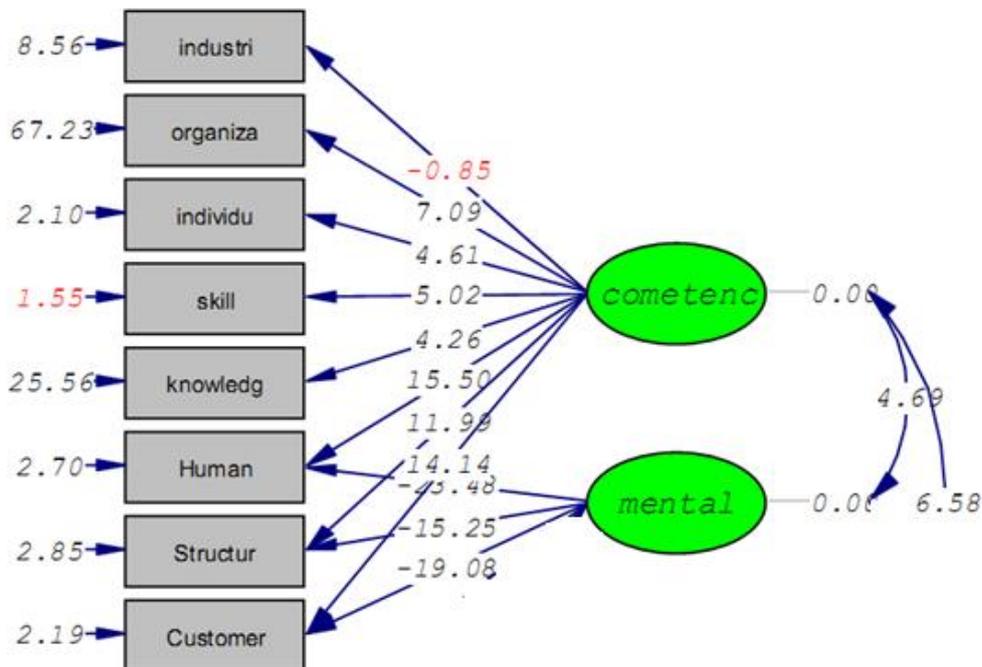
Index	The external dimension of the model	Optimal parameters
Area covered by the chi-square with degrees of freedom	$\frac{\chi^2}{d.f} \dots > 30.97$	$\frac{\chi^2}{d.f} \dots > 0$
Goodness of fit index	GFI=0.94	GFI>0.09
The root mean square error of the estimate	RMSEA=0.047	RMSEA<0.05

Adjusted goodness of fit index	AGFI=0.80	1<AGFI<0
Not a normal fit index	NNFI=0.94	NNFI>0.09
The comparative fit index	CFI=0.96	CFI>0.09



Chi-Square=2415.99, df=78, P-value=0.00000, RMSEA=0.047

Figure (1): Standard values of the components of the model equation



Chi-Square=2415.99, df=78, P-value=0.00000, RMSEA=0.047

Figure (2): Significant amounts of components of the proposed model

Discussion and Conclusion

The study results are so stable and reliable because we use confident instrument to measure indicators like standard and detailed exams. We have five standard exams to evaluate project managers' competencies that it is not regular in human resource studies in level of thesis and also we use valid and reliable questionnaires to evaluate intellectual capital and effectiveness of project managers. These findings indicate an investment on the human resources play an important role to organization success. The concept intangible success factors is used to refer to individual intangible assets and also the activities related to improving or utilizing the assets, i.e. any intangible phenomena that are to be measured. In addition, the results reveal that research institutes operating in Iran's Energy ministry have knowledge human resources works in traditional structures in which the price is not intellectual capital.

As previously mentioned, intellectual capital is a group of collective mental abilities or key knowledge which can act as a source to increase organizational competence and improve business performance. Unfortunately, the project oriented organizations like research institutes in areas of energy ministry in Iran the main focus is on project management knowledge and expertise rather than management of intangible assets. Intangible assets and intellectual capital are the sources of value and the levers for sustainable business performance in today's competitive economic context. Firms, organizations, as well as governments require tools and techniques to manage, measure, and report their key value drivers. The problem is that most traditional management systems were designed for an era when tangible assets dominated. Accounting systems, as just one example, appear to completely ignore most intangibles and knowledge-based assets.

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