

The Effect of Intellectual Capital on Innovation: A Case Study of an Institute for Advanced Studies in Basic Sciences Located in the Science and Technology Park of Zanjan

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Abstract

The present research aims to investigate the effect of intellectual capital on innovation in Zanjan Science and Technology Park (STP) during 2013. This study was conducted based on the quality-correlation method. The research questionnaire was distributed between employees who worked for any of the firms inside the STP. In general, 220 employees work in Zanjan Science and Technology Park, 139 of whom were selected using the Cochran's formula to reply to the questionnaire. Structural equation modeling was used to analyze the data. The results of the correlation test revealed a significant positive relationship between intellectual capital and innovation. The elements of structural capital and human capital did not indicate any significant relationship with innovation. However, it was found that the elements of intellectual capital (i.e. human capital, structural capital, and relational capital) can be used as predictors of innovation in our case study.

Keywords: Intellectual capital; Innovation; Structural capital; Human capital; Relational capital; Zanjan Science and Technology Park

Introduction

Today, with the global trend toward knowledge-based economies, firms need embrace innovation in order to survive and grow in intense competition. Innovation seems to be a competitive advantage which encourages organizational growth and acts as a growth engine enabling firms to show higher efficiency in the global economy [1]. Liao and Wu define innovation as a new product or service, a new production process technology, a new structure or administrative system, or a new plan or program pertaining to organizational members. Therefore, firms should seek the right culture, structure, systems, and processes which facilitate innovation and increase their innovative capacity [1].

Implementation of innovation depends on the capital changes in an organization. Capital was modified from its traditional economic basis to first comprise human capital (HC), and then social capital, and finally intellectual capital (IC) implications. These changes in the forms of capital have attracted the attention of a number of scholars as a key factor in fostering innovation [2-5].

This paper's definition of innovation outlines the intermediating role of relational capital (RC) and HC between structural capital (SC) and innovation. Based on the literature, innovation is a creative action which is necessary for creating SC. SC refers to organizational culture, organizational processes, organizational learning [6] which leads to HC and RC. HC refers to individual knowledge, skills, abilities, and experiences of the employees in an organization [7]. RC refers to customers and relationships between stakeholders.

Due to the flexible structure of STP, SC could lead STP's firms toward innovative environments via their internal and external communications (i.e. RC) and also via benefiting from employees knowledge, ability and experiences (HC).

Theoretical Framework

In this section, we will first define the variables of the study and

then review the literature about the effect of IC on innovation.

Intellectual capital

Today, IC has become one of the main instruments for attaining more productivity and success among organizations. Therefore, organizations need to foster this type of capital [8]. There is no consensus regarding the definition of IC, hence the different definitions based on the researchers' personal points of view and various conceptual models.

All categories of IC commonly focus on the three dimensions of HC, SC and RC [9]. For Example Edvinson and Malone [10] have pointed out to three dimensions of IC as including: SC, HC, and RC (Table 1).

Finally, it should be noted that the three types of capital (i.e. SC, HC, and RC) can affect the performance and success of an organization. Therefore, the existence of a relationship between them is of great importance and organizations shouldn't focus on improving one capital only.

Literature Review

According to the literature, IC is considered as one of the most important sources of competitive advantage [6,11,12]. Evidence shows that IC has a positive impact on organizational innovation [2,4,13].

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Elements	Definitions	Author
SC	SC refers to structures and processes within an organization which employees use them to employ their knowledge and skills.	Vergauwn et al.
	This capital includes structures as well as mechanisms which their basic role is to support the employees to achieve to an optimum intellectual performance and ultimately an optimum performance in the business.	Alam Tabriz et al.[8]
	Edvinson and Malone argued that SC supports and increases the staff's performance but it also remains even after the time an employee leaves the organization.	Edvinson et al. [10]
HC	HC has been defined as the set of knowledge, skills, abilities, and experiences of the employees in an organization that help with creating value and solving business problems.	Norma et al. [7]
	HC is considered as the most important asset of an organization, an essential resource for creativity, as well as, innovation, and also a competitive advantage for the organization.	Campbell, Bamir et al.
	Organizations which benefit from a high share of HC, act more innovatively and solve their problem faster.	Alpkan et al. [20]
RC	RC refers to all the knowledge within the relationships in an organization with its external environment including customers and partners.	Chen [6]
	RC is considered as an essential component of intellectual capital, referring to an embedded value in marketing channels and relations through which organizations lead their business, and consider their customers as the most important part of that capital.	Bontis et al. [3]

Table 1: Definitions of structural capital, human capital and relational capital.

Subramaniam [13] argue that human, organizational, and social capital as well as the interactive relations among individuals affects both incremental and radical innovation. It has been shown; on the one hand, that SC has a positive effect on innovative capacity. On the other hand, HC, which is in interaction with social capital, has a positive effect on innovation.

In a study about the effect of IC on organizational innovative propensity, Aldujaili maintains that the main hypothesis of the study was rejected, and just the effect of the SC and HC on organizational innovation was confirmed. RC also had no significant effect on innovation. In fact, Iraqi manufacturing firms showed a weak relationship with suppliers, customers, and competitors. Conversely, Delgado [4] investigated the effect of HC, technological, relational and social capital on incremental and radical innovation and found that intellectual properties directly affect innovation; additionally, HC has a mediating role in the relationship between RC and radical innovations.

Zerenler et al. [5] also considered the three indicators of SC, HC, and RC regarding IC and found that all the three dimensions of IC have a positive and strong relationship with innovative performance. RC had a more significant effect on innovative performance, while the two other dimensions of HC and SC had a less significant effect.

In general, it seems that most studies in the IC literature focus on the three indicators of HC, SC, and RC [14]. As the first indicator, HC has been defined as the set of knowledge, skills, abilities, and experiences of the employees that help with creating value and solving business problems and it is considered a source of innovation [15].

SC refers to structures and processes within an organization which employees can use in order to employ their knowledge and skills [3]. RC, the third indicator of IC, refers to relations with key beneficiaries including staff, customers, stakeholders, and other individuals who benefit from financial promotions [16].

Conceptual framework

Innovation in an organization does not occur because of shortage; rather, the organizational structure prepares the conditions as a context. The organizational structure is the indicator of the relationships between different units within an organization and their flexibility. Therefore, innovation resources include all organizational structures and strategies, customer demands, and interaction with beneficiaries. The STPs' structure also requires the organization to be innovative with

the products and services which it offers.

According to Russelle, the organizational structure has been considered as the most effective factor in relation to innovation, and it has been argued that organizational structural prepares the context for innovation. This capital is obtained through mediating human and relational capitals.

Bounfour introduced the IC-dVAL approach and recognized four dimensions of SC, HC, market capital, and innovation, and incorporated these four dimensions in an integrated framework, and then suggested a relationship between entries (resources), processes, intangible assets, and firm's innovative performance. Therefore, culture creates innovation, and resources can continue just when RC and HC exist in an organization and these capitals result in innovative behaviors in the organization.

Parsons also introduced the theory of structural-functionalism and argued that every system includes some structures and each structure has different functions. Parsons recognized culture as a determinant in a society which any kind of change in it leads to a change in other sections of the society. Since a society is built and continues to live based on norms, values and beliefs, culture is the source of all cultural changes. As regards the relationship between HC and innovation based on Longo's model (2007), HC is first the foundation of IC; second, a constant source of innovation renewal for the organization; third, is able to understand the issues; and fourth, can benefit from the experiences to create value. With this respect, in their classification of IC, Edvinson and Malone [10] has introduced the SC as a supporting factor for HC.

In a study of the effect of RC and innovation among STPs' firms, Palmberg and Hult [17,18] argued not only does innovation involve technological matters, but also other variables which are recognized as sources of innovation such as customer demand, market, and collaboration with customers. Technological change is not likely to provide customers with instant value, however, new technologies can attack an established market and therefore be considered as a source of innovation. Firms need to collect data about customer needs before they seek new ways to fulfil them sine it is the customers who enable firms to create value.

Hult et al. [18] found that entrepreneurial market orientation and learning are key predicting variables for innovation. It should be noted that three components of IC have intra-correlation. The interactive

relationships between the three components of IC could be a part of the positive effect of HC on SC, because SC can result in distribution of the individuals' technical knowledge across groups. SC also has a positive effect on RC. In fact, RC is the knowledge which defines the relations of an organization with customers and external stakeholders. As a part of the RC mix, HC plays a role in all the administrative activities in an organization [14]. RC has a positive influence on HC because RC can increase both HC and SC as it refers to an organization's ability to establish positive interaction with external stakeholders, gain their perceptions of the organization, and exchange information with customers. The conceptual model of the research is presented below which shows the relationship between IC (i.e. HC, SC and RC) with innovation (Figure 1).

Research Methodology

This research falls into the category of empirical studies and employs the qualitative correlation method. The questionnaire was distributed between the firms' employees who worked for any of the firms inside the STP. In general, 220 employees work in Zanjan STP of whom 139 individuals were selected according to the Cochran's formula to reply to the questionnaire. The questionnaire was prepared in the form of statistical samples considered for this study (including all employees working in the park firms). Structural equation modeling was used to analyze the data. The results of the correlation test revealed a significant positive relationship between IC and innovation; and the effect of IC on innovation was identified after analysis of the collected data. Reliability was measured based on the two criteria of Cronbach's alpha and the composite reliability (CR). Validity was also determined by measuring the convergent and divergent validity. Convergent validity determines whether the correlation between a construct and the questions related to that construct is sufficient, while divergent validity compares the correlation between a construct and the questions related to that construct; and the correlation of that construct with other constructs. Table 2 shows these values.

Results

Descriptive statistics based on demographics

The descriptive statistics of the study show that 64% of the participants were male and 36% were female. Regarding education, most participants (65 per cent) had a bachelor's degree (BA), while the frequency of individuals who had a PhD degree was zero. In terms of work experience, the highest frequency (60 per cent) was related to the

Measure	Cronbach's alpha	Composite reliability	Convergent validity	Divergent validity	Number of items	Scale
Criterion	Up to 0.7	Up to 0.7	Up to 0.4	-	-	-
SC	0.75	0.83	0.50	0.711	5	Interval
HC	0.70	0.74	0.40	0.581	6	Interval
RC	0.73	0.81	0.42	0.651	6	Interval
Innovation	0.71	0.73	0.37	0.565	6	Interval

Table 2: The values for convergent validity, divergent validity, composite reliability, Cronbach's alpha.

Indicator	Frequency	Lower limit	Upper limit	Mean	Standard deviation
IC	103	13.73	45.63	25.64	6.14
SC	103	4.2	17.4	8.66	2.97
RC	103	3.33	24.67	11.88	3.46
HC	103	6.17	20.33	10.86	2.78
Innovation	103	0	16.67	9.07	2.81

Table 3: Descriptive statistics based on the indicators of the study.

category of 'under 5 years'; and the lowest frequency was related to the category of 'between 16-20 years'.

Descriptive statistics based on the indicators

Based on the table above, the minimum and maximum score of the indicators are based on the individuals' scores in each pertinent indicator. For example, the minimum SC score of the individuals is 4.20, whereas their maximum score is 17.20. Based on the difference between the minimum and maximum scores, the standard deviation has been measured 2.97 for SC.

Hypotheses test

Simple linear regression was used to examine the linear relationships of the variables. The purpose of using regression is to measure the linear relationships of the indicators with the dependent variable (i.e. innovation)

As it can be seen in Table 3, according to the regression coefficients with values greater than 0.3, the relationships between the variables are positive, however, with average or less than average strength. On the other hand, since the significance level is 0.000, which is less than $\alpha = 0.01$, none of the hypotheses are rejected. In other words, the linear relationship between the variables is supported. As for the significance level of 0.026, which is less than $\alpha = 0.05$, the hypothesis for existence of a relationship between SC and innovation is rejected. The measurement models shown in Tables 4 and 5, Figures 2 and 3 explain the main and 5 sub-hypotheses.

Defining the 6th sub-hypothesis through using Pearson correlation coefficient

How is the correlation between RC and HC in Zanjan University STP firms?

Based on the test results above and the correlation coefficient in the significance level of 0.01, there is a significant correlation between HC and RC (Table 6).

Conclusion and Discussion

A study of characteristics and factors that affect organizational innovation demonstrates that with technological growth, more

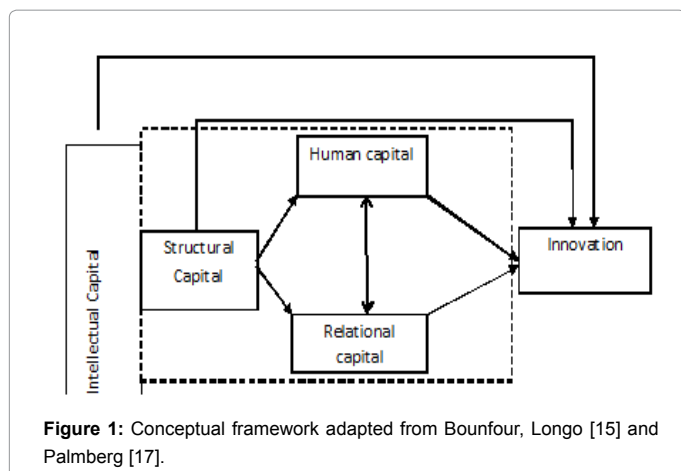


Figure 1: Conceptual framework adapted from Bounfour, Longo [15] and Palmberg [17].

Indicators	Regression coefficient	Sig. level
IC on innovation	0.422	0.000
SC on HC	0.548	0.000
SC on RC	0.491	0.000
HC on innovation	0.378	0.000
RC on innovation	0.381	0.000
SC on innovation	0.220	0.026

Table 4: The linear relation of IC dimensions with innovation.

Results	Coefficient (B)	Sig level (t)	Effect	Hypotheses
Positive and significant effect	0.469	5.413	The effect of IC on innovation	Main hypothesis
Positive and significant effect	0.582	8.227	The effect of SC on HC	Sub-hypothesis 1
Positive and significant effect	0.594	10.348	The effect of SC on RC	Sub-hypothesis 2
No effect	0.056	0.394	The effect of HC on innovation	Sub-hypothesis 3
Positive and significant effect	0.517	3.732	The effect of RC on innovation	Sub-hypothesis 4
No effect	-0.001	-0.009	The effect of SC on innovation	Sub-hypothesis 5

Table 5: The hypotheses test results.

	HC	RC
HC	1	.545**
RC	.545**	1

0.01 **sig level

Table 6: How is the correlation between RC and HC in Zanjan University STP firms.

in achieving their goals in today's ever changing environment is investigating and identifying the factors that enhance innovation. In this line, the relationship between organizational innovation and different variables has been tested by various studies in the literature. IC has been identified as one of the prerequisites and factors that affect organizational innovation.

IC in STPs is one of the important and effective factors that encourage innovation [4,13]. As an indicator of a range of knowledge-based assets, IC leads to the improvement of the competitive situation of an organization through increasing value for key stakeholders. Staff, managers, leaders, and supervisors all are considered as a STP's capital. This capital is recognized as a resource-based theory and it could also be considered a strategic source [19-24].

The main hypothesis of the study was confirmed. Therefore, it suggests that IC affects firms' innovation in a STP. Due to the intangible assets in the STP, development of these assets moves the firms towards the activities in which individuals are motivated to recognize and exploit entrepreneurial opportunities in order to reach higher innovation levels. Entrepreneurial activities ultimately lead to better innovative performance for the firms and STPs' firms can always be innovative and survive in the competitive environment. Hence, the findings of this study are in line with studies by Delgado [4], where they refer to IC as a potential source of competitive advantage for organizations which makes them grow and finally results in exploitation of entrepreneurial opportunities and facilitation of innovation in firms.

As the results of the study revealed, the main hypothesis as well as the first, second and fourth sub-hypotheses of the study were confirmed. In other words, it was positively and significantly confirmed that IC affects innovation, SC affects HC, SC affects RC, and finally RC affects innovation [25-30].

Suggestions

- It is recommended that knowledge-based firm managers enhance IC and hence innovation by creating and reinforcing a suitable culture within the organization.
- RC alone does not guarantee constant innovation. STPs should also pay attention to HC to make ensure continued innovation.
- Managers can encourage their staff to acquire the most up-to-date knowledge and information through creating groups and knowledge teams.

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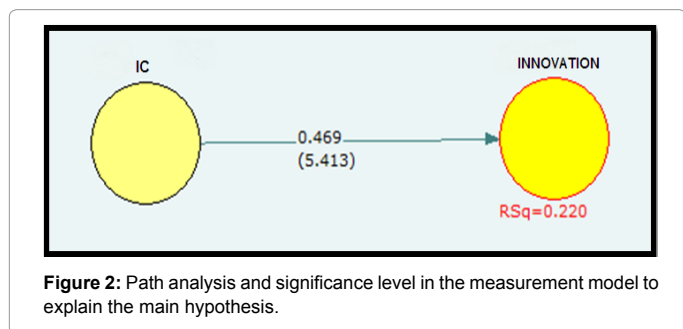


Figure 2: Path analysis and significance level in the measurement model to explain the main hypothesis.

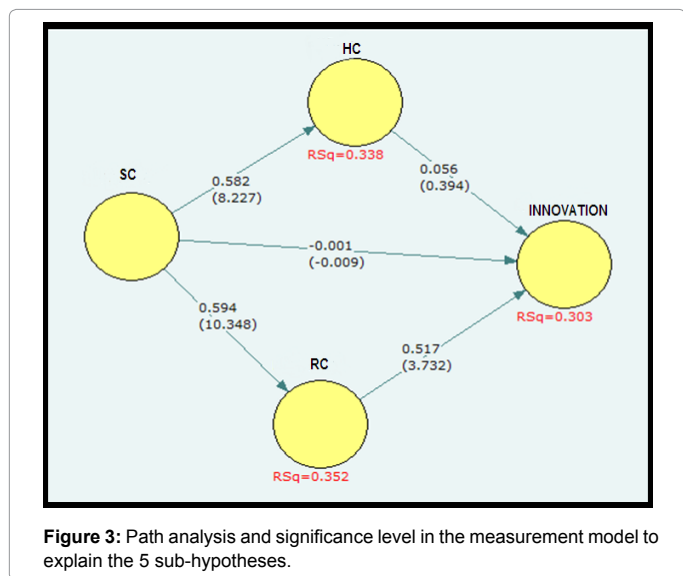


Figure 3: Path analysis and significance level in the measurement model to explain the 5 sub-hypotheses.

complex organizations, and organizational competition, the effect of innovation among managers, staff, researchers and experts in various disciplines has become more important. What helps organizations

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