

## The interplay between intellectual capital and new product development: an empirical investigation of Agricultural Research Institutes in India

AJAY KUMAR SAINI<sup>1</sup>, HARPREET SINGH GREWAL<sup>2</sup> and HARISH KUMAR SINGLA<sup>3</sup>

<sup>1</sup>Uttarakhand Technical University, Dehradun, <sup>2</sup>Omkarnand Institute of Management and Technology, Rishikesh

<sup>3</sup>National Institute of Construction Management and Research Indore

**ABSTRACT :** The purpose of the paper is to see the relationship of intellectual capital with new product development in agricultural research institutes in India. A questionnaire based survey was conducted and 32 agricultural research institutes were personally contacted and the responses were recorded through 5-point scale questionnaire. Structural Equation model was used for the analysis purpose and it is found that intellectual capital has a significant impact on the new product development of agri-research institutes in India.

**Key words:** Agriculture Research Institutes, human capital, intellectual capital, relational capital and structural capital,

### JEL Classification: I23, O13, O32, J24, Q16

The Indian agricultural research system has a long and distinguished history that evolved from a decentralized, imperial system into a highly centralized one created to respond to the food crisis in the 1960s. With the goal of increased food production as the driving force, the system grew rapidly, through both central and state fiscal appropriations.

Around 1905, the Imperial (now Indian) Agricultural Research Institute (IARI) was established, along with six agricultural colleges. A milestone in the history of Indian agricultural R&E system was the establishment of the Imperial (now Indian) Council of Agricultural Research (ICAR), in 1929, as a semi-autonomous body to promote, guide, and coordinate agricultural research nationally. Post-independence, in 1957, the All India Coordinated Research Projects (AICRPs) came into existence under ICAR to promote multi disciplinary and multi-institutional research. In 1965, ICAR was mandated to coordinate, direct, and promote agricultural research in India by overseeing all the research stations previously controlled by commodity committees and various government departments. Subsequently, the Department of Agricultural Research and Education (DARE) was created in the central Ministry of Agriculture and Farmers Welfare to facilitate linkages between ICAR and the central and state governments and with foreign research organizations.

The Indian Council of Agricultural Research deals with a number of disciplines and commodities in Crops, Horticulture, Animals, Fisheries, Engineering and Resource management through a network of 48 Institutes, 5 Bureaus, 11 Project Directorates, 32 National Research Centers and 91 All-India Coordinated Research Projects. Further, the Central Agricultural University and 40 State Agricultural Universities are the constituents of the National Agricultural Research System.

Globalization and rapid developments in science, privatization and liberalization of the economy, and challenges of sustainable resource management and diversification are now placing new demands on the system. There is a need for much greater awareness of the development, protection, commercialization, and application of intellectual property and technologies in enhancing research impact and access to modern scientific tools.

*Therefore, research and development focus along with institutional framework and policy support needs to match emerging agricultural scenario of the country. Through this study, an attempt has been made to understand the extent to which agricultural research institutes have been successful in creating an impact of the research activities undertaken by them. Here, the specific reference is one of the outcomes of research, that is, new product development and the ability of the*

*agricultural research institutes to manage their intellectual capital resources.*

In the present organizations, sustainable competitive advantage is seen through intellectual capital intangible assets. Despite the fact that intellectual capital and new product development are crucial to organizations, few studies focus on the relationship of these two factors. In one of the studies conducted in the past, it was concluded that approximately 32.4% of sales in an organizations is due to new products (Griffin, 1997). Developing new products is necessary for long term survival and sustainable competitive advantage (Cooper, 1998; Panne *et al.*, 2003; Rein, 2004). Chen *et al.* (2006), discusses the relationship between intellectual capital and new product development performance, but the study does not address how intellectual capital has an impact on new product development. Moreover, the studies have not reflected the influence of intellectual capital on new product development in research and development organizations including agricultural research.

Hence, this study is an attempt to fill the research gap by exploring the influence of intellectual capital upon new product development. This study explains the degree to which the independent variable i.e. intellectual capital influences the dependent variable i.e. new product development.

### ***Concept of Intellectual Capital***

Intellectual capital is the primary factor of creating sustainable competitive advantage for the organizations. It is the dynamic and knowledge based firm-specific system of intangible resources and activities. The interactions of these intangible resources with tangible resources generate sustainable competitive advantages. The various definitions of intellectual capital have provided different perspectives from where they have arisen. However, the common thread which runs through these diverse perspectives is the fact that intellectual capital is a multidimensional concept, consisting of the combination of human, structural or organizational and relational resources of the firm. Intellectual capital embraces every single intangible that is supposed to generate future benefits for organizations and do not have a physical or financial embodiment (Lev 2001).

(MERITUM, 2002) defines intellectual capital as the combination of an organization's human, organizational and relational resources and activities. It consists of employees' knowledge, skills, experiences and abilities;

the R&D activities, the organizational routines, procedures, systems, databases and its Intellectual Property Rights as well as all of the resources linked to its external relationships; such as with its customers, suppliers, R&D partners, etc.

### ***Components of Intellectual Capital***

Various models and classifications of intangibles have been compared by Bukh *et al.* (2001) and concluded that they refer to some similar things. Although different terms have been used by different authors, the classification of three categories is confirmed by most of them (e.g., Mouritsen *et al.*, 2002; Sanchez *et al.*, 2000; Sullivan, 2000).

The categorization of intangibles proposed by Meritum appears to be used most popularly in practice and academic research (OECD, 2006). According to Meritum (2002) guidelines, intangibles comprise three major elements: human capital, structural capital and relational capital.

***“Human capital*** is defined as the knowledge that employees take with them when they leave the firm. It includes the knowledge, skills, experiences and ability of people. ***Structural capital*** is defined as the knowledge that stays within the firm at the end of the working day. It comprises the organizational routines, procedures, systems, cultures, databases, etc. ***Relational capital*** is defined as all resources linked to the external relationships of the firm, with customers, suppliers or R&D partners. It comprises that part of Human and Structural Capital involved with the company's relations with stakeholders (investors, creditors, customers, suppliers, etc.) plus the perceptions that they hold about the company”

### ***New Product Development***

New product development is a key strategic activity in research institutions as new products make an increasingly significant contribution. For survival and growth, enterprises need to persistently develop successful products. The research institutes are considered as the backbone of growth of industry and development of the nation. It is important for these research institutes to keep increasing their efficiency and effectiveness. *Therefore, this paper is an attempt to find out the impact of intellectual capital on new product development in agriculture research institutions in India.* According to DeJong and Hertzog (2007), investment in

employees is key to innovation in organizations. Chen, *et al.* (2006) classifies critical success factors in new product development as human capital, structural capital and relational capital. Critical success factors of new product development have inspired a multitude of research works across the world. These include alignment with the customers' needs, defining the target market, empowering employees to apply new ideas, having in-house potentials for innovation and having highly motivated employees and supportive organizational culture related to new product development operation (Chen *et al.*, 2006).

The various benefits of technology transfer are also contributors to the competitive advantage, increased productivity and development of local industries (Liao and Hu, 2007). Similarly, new technologies enable firms to develop innovative new products (Taylor, 2010). For survival and growth, enterprises need to persistently develop successful products, as these become the foundation of survival and growth.

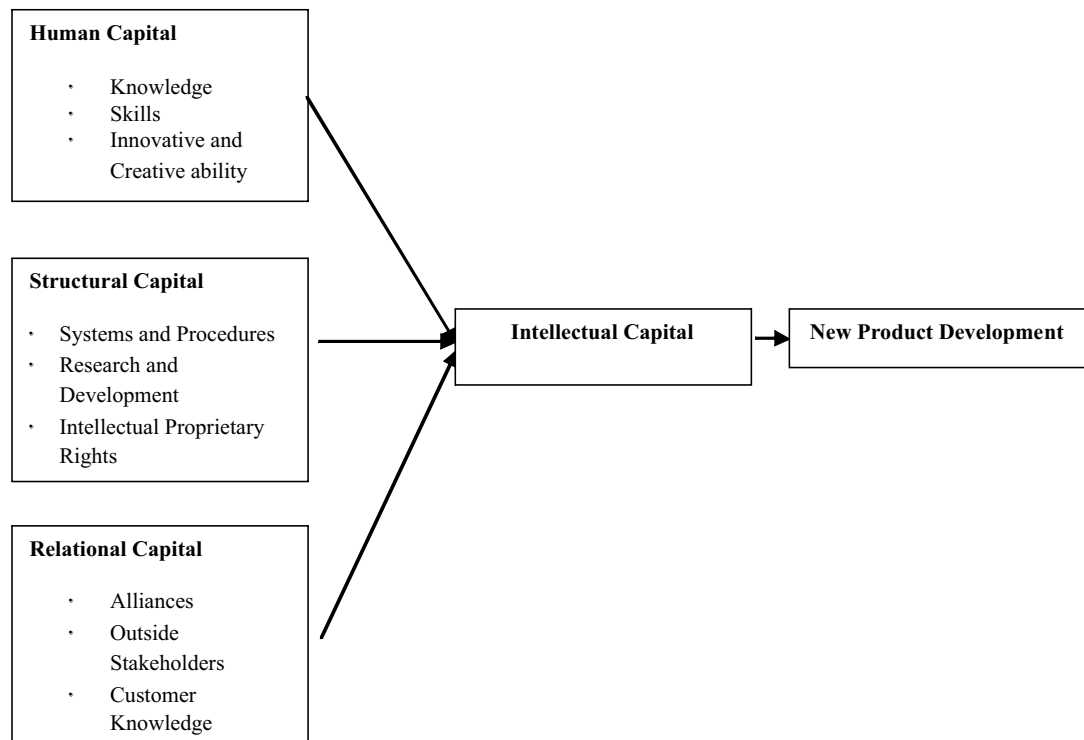
**Conceptual Framework**

The intangibles are becoming major factors of

success for today's knowledge based organizations. The attention paid to intellectual capital, patents, processes, management skills, and technologies by the organizations is unprecedented. The available literature, in most of the cases, shows a relationship between an organization's performance and intangibles.

Bontis, (1998) suggests a valid, reliable, significant and substantive causal link between dimensions of intellectual capital and organizational performance. The focus of this paper is to see the impact of human capital, structural capital and relational capital (Overall Intellectual capital) on the new product development (Figure-1).

The research institutions across the world have been studied in the past vis-à-vis their performance (Hsu and Wang, 2012; Kazan *et al.*, 2012; Nejadirani *et al.*, 2012; Phusavat *et al.*, 2011; Hermans and Kauranen, 2005; Diez *et al.*, 2010; Bramhandkar *et al.*, 2007; Bollen *et al.*, 2005; Bontis, 2001; Carlucci *et al.*, 2004; Kim and Kumar, 2009; Pedrini, 2007; Reed *et al.*, 2009; Cater and Cater, 2009; Coccia, 2004; Tikoria *et al.*, 2010; Clarke *et al.*, 2011) and it has been found that intellectual capital has a prolific influence on the performance of these research



**Fig. 1:** Conceptual Framework of the Study

*institutes*. The components of intellectual capital (human, customer, process, and renewal/ development) have been defined by Skandia model when it was first developed in 1991. *The researchers have developed the 5 point scale comprehensive questionnaire based on the above definition.*

The measurement and development of intellectual capital is possible only through structural capital, without which it remains only human capital. Structural capital is the critical link that allows intellectual capital to be measured at an organizational level (Bontis, 1999). Relational capital reflects the value of organizational relationships. In most of the organizations, this is a more or less a neglected area. Organizations do not recognize the wealth of knowledge from their clients and suppliers. It represents the potential of an organization because of ex-firm intangibles. These intangibles consist of knowledge embedded in customers, suppliers, the government or related industry associations. All three collectively play a vital role in the performance of an organization.

## **MATERIALS AND METHODS**

*Identification of Variables*-An attempt is made to see the impact of intellectual capital on the performance of agricultural research institutes in India. For the present study, *new product developments in last five years (2008-2013) are identified as a performance variable, which is the dependent variable in the study.*

Human Capital, Structural Capital and Relational capital are observed variables  
Where

- Human capital is measured through Knowledge, Skills and Innovative and Creative ability,
- Structural capital is measured through Systems and Procedures, Research and Development and Intellectual Proprietary Rights
- Relational capital is measured through Alliances, Outside Stakeholders and Customer Knowledge
- Intellectual capital is a latent variable

### *Sampling & Data collection*

For the purpose of research, a comprehensive questionnaire was developed that measures the human capital, structural capital and relational capital on five point scale, where 1 = strongly disagree, 2= disagree, 3= undecided, 4= agree, 5 = strongly agree. This

questionnaire consisted of 81 items covering all the dimensions shown in table-1. The data was tested for normality as well as for reliability i.e. how well the set of questions relating to each of the components of intellectual capital, are able to measure this component using Cronbach's Alpha (0.90), which is quite good. The final questionnaire was served to the heads of agricultural research institutes in India (32 randomly selected agricultural research institutes out of 99), which means appx. 33% of the institutes were covered.

### *Hypothesis Development*

The following hypotheses were prepared for the analysis purpose.

H<sub>1</sub> = Human Capital is appropriate measure for Intellectual capital.

H<sub>2</sub> = Structural capital is appropriate measure for Intellectual capital.

H<sub>03</sub> = Relational Capital is appropriate measure for Intellectual capital.

H<sub>04</sub> = Intellectual Capital has a positive impact on new product development of Agricultural research institutes in India

## **RESULTS AND DISCUSSION**

### *Descriptive Statistics*

Table-1 presents a summary statistics of the variables and it can be seen that the average score is above 3 on a scale of 5 for all the variables, which indicate that research institutes consider these components to be important for new product development. The average new product developments are approximately 25 in last five years i.e. 5 per year.

### *Correlation Analysis*

It can be observed from Table-2 that new product development has a positive significant correlation with Structural, relational and intellectual capital. It is an indication that the new product development in agricultural research institutes is directly influenced by human, structural, relational and intellectual capital. However, significant inter correlation between human, structural and relational capital can lead to multi-collinearity problem, therefore, VIF (variance inflation factor) test is conducted, the results for VIF are above 5 which indicate strong presence of multi-collinearity. This may lead to distortion of regression.

**Table 1: Average Scores of the Intellectual Capital Components**

Institute	Human Capital	Structural Capital	Relational Capital	Intellectual Capital (Latent Variable Predicted through model)	New Product Development in Last 5 years
1	4	5	4	0.94	30
2	4	5	5	1.161	32
3	2	3	2	-0.814	21
4	2	2	3	-1.126	18
5	4	3	2	-0.414	24
6	2	3	2	-0.833	20
7	4	4	5	0.629	27
8	4	4	3	0.225	25
9	2	3	3	-0.669	19
10	3	4	4	0.161	21
11	5	5	5	1.577	45
12	1	2	3	-1.448	10
13	4	4	4	0.465	28
14	2	3	3	-0.669	19
15	5	5	4	1.413	46
16	4	4	4	0.502	30
17	3	4	3	-0.04	20
18	2	3	3	-0.612	22
19	4	4	4	0.465	28
20	4	5	4	1.034	35
21	2	2	2	-1.459	10
22	3	3	3	-0.516	18
23	4	4	3	0.056	16
24	2	3	3	-0.744	15
25	3	3	3	-0.667	10
26	5	5	4	1.808	67
27	3	2	2	-1.212	14
28	4	5	4	0.921	29
29	2	4	3	-0.193	21
30	4	4	3	0.282	28
31	3	4	4	0.218	24
32	1	4	3	-0.44	17
Average	3.16	3.69	3.34		24.66

**Table 2: Correlations**

	Human Capital	Structural Capital	Relational Capital	Intellectual Capital	New Product Development
Human Capital	1				
Structural Capital	0.720*	1			
Relational Capital	0.598*	0.750*	1		
Intellectual Capital	0.889*	0.920*	0.858*	1	
New Product Development	0.746*	0.745*	0.597*	0.788*	1

\* Correlation is significant at the 0.01 level (1-tailed).

#### Structural Equation Model

In order to overcome the problem of multicollinearity, SEM model is built where Human Capital, Relational Capital and Structural Capital are considered as observed variable and intellectual capital is taken as

latent variable. A measurement SEM model is used to see if Human Capital, Relational Capital and Structural Capital are fitting to intellectual capital and if intellectual capital has an impact on new products development. The results are presented in Table-3 and Figure-2 given below. Where NPD is new products development, HC is Human

**Table 3: Measurement and structural model results**

Measurement variables: HC, SC, RC, NPD

Latent Variable: IC

No. of Observations:45

Measurement	Fitting Latent	Coefficient	Std. Error	Z value	P value
HC*	IC	0.999	----	----	0.000
	Intercept	3.156	0.198	15.93	0.000
SC*	IC	0.944	0.167	5.63	0.000
	Intercept	3.687	0.167	21.96	0.000
RC*	IC	0.724	0.153	4.71	0.000
	Intercept	3.343	0.150	22.21	0.000

\*significant at 5%

Latent Independent Variable: Human Capital

Dependent Variable: New Product Development

No. of Observations:45

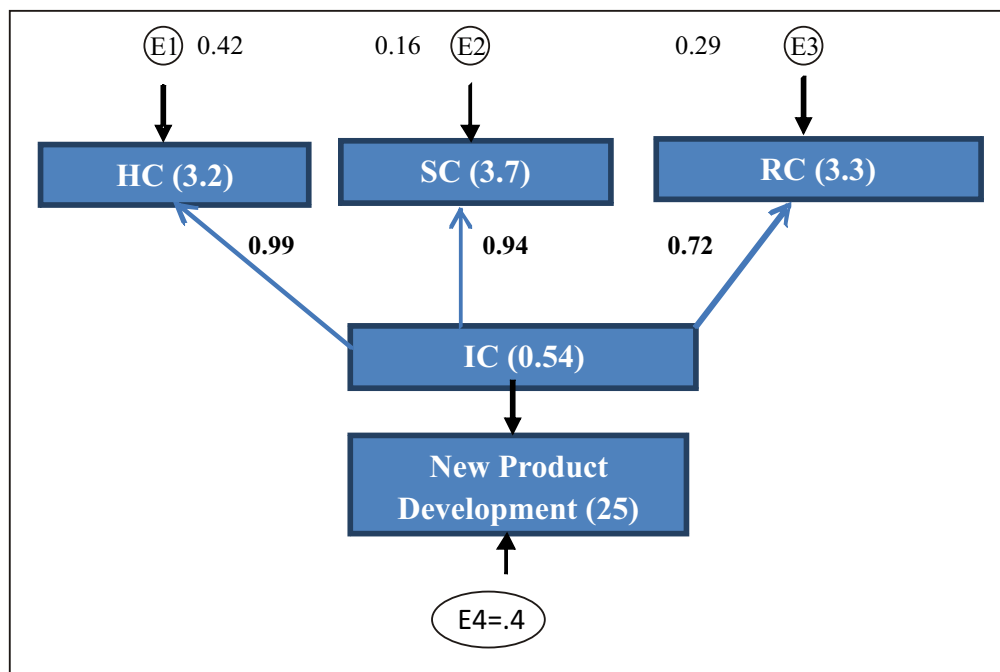
Measurement	Fitting Latent	Coefficient	Std. Error	Z value	P value
New Product Development*	IC	10.393	1.878	5.53	0.000
	Intercept	24.656	2.017	12.22	0.000

Fit statistics: LR Test of Model Vs. Structured: chisquare=3.36, and  $p > \text{chisquare} = 0.1860$

CFI (Comparative fit Index): 0.982

TLI (Tucker-Lewis Index): 0.947

\*significant at 5%



**Fig. 2: SEM output**

Capital, SC is structural Capital, RC is relational Capital and IC is intellectual Capital.

As observed in above tables, human capital, relational capital and structural capital are fitting the measurement model ( $p = 0.000$ ) and for the structural model, the Chi square is significant ( $P > \text{chi}^2$ ) and the

values of CFI and TLI are above .9, so the structural model is also significant. Based on the above, we can conclude that intellectual capital is significantly affecting the new product development. The model is a good fit and on the basis of above results all the above hypotheses, i.e. human capital is appropriate measure for Intellectual capital, Structural capital is appropriate measure for

Intellectual capital, Relational Capital is appropriate measure for Intellectual capital and Intellectual Capital has a positive impact on new product development of Agricultural research institutes in India are accepted.

## CONCLUSION

Analyzing the role of intellectual capital, this research paper concentrated on the role of intellectual capital on the new products development in agricultural research institutes in India. The empirical analysis for this study shows that intellectual capital has a significant impact on the new product development, which is consistent with the existing view. This leads authors to conclude that new product development in agricultural research institutes in India is driven by intellectual capital and research institutions must focus on developing their internal as well as external capabilities to strengthen their organizations. In times to come, these institutions will play a vital role in agricultural development of the country by providing new developments, facilitating farmers, which is need of the hour. Every year, so many farmers commit suicide in India, because of lack of resources and lack of understanding in terms of modern methods of farming. This is where; these institutions have to play a vital role.

## REFERENCES

- Bollen, L., Vergauwen, P. and Schnieders. S. (2005). Linking intellectual capital and intellectual property to company performance. *Management Decision*, 43(9):1161-1185.
- Bontis, N. (1998). Intellectual capital: an exploratory study that develops measures and models, *Management Decision*, 36 (2):63-76.
- Bontis, N. (1999). Managing organizational knowledge by diagnosing intellectual capital: framing and advancing the state of the field. *Int. J. Technology Management*, 18, (5/6/7/8):433-463.
- Bontis N. (2001). Assessing knowledge assets: a review of the models used to measure intellectual capital, *International Journal of Management and Reviews*, 3: 41-60.
- Bramhandkar. A., Erickson, S. and Applebee, I. (2007). Intellectual Capital and Organizational Performance: an Empirical Study of the Pharmaceutical Industry, *Electronic Journal of Knowledge Management*, 5(4): 357-362.
- Bukh, P.N., Larsen, H.T. and Mouritsen, J. (2001). Constructing intellectual capital statements, *Scandinavian Journal of Management*, 17 (1): 87-108.
- Carlucci, D., Marr, B., and Schiuma, G. (2004). The knowledge value chain: How knowledge management impacts business performance. *International Journal of Technology Management*, 27(6/7): 575-590.
- Cater, T., and Cater, B. (2009). (In) tangible resources as antecedents of a company's competitive advantage and performance, *Journal for East European Management Studies*, 14(2): 186-209.
- Chen, Y.S., Lin, J.M.J., and Chang, C.H. (2006). The influence of intellectual capital on new product development performance-the manufacturing companies of Taiwan as an example, *Total Quality Management and Business Excellence* 17(10), 1323-1339.
- Clarke, M., Seng, D. and Whiting, R.H. (2011). Intellectual Capital and Firm Performance in Australia, *Journal of Intellectual Capital*, 12(4): 505-530.
- Coccia, M. (2004). New models for measuring the R&D performance and identifying the productivity of public research institutes, *R&D Management*, 34(3): 267-280.
- Cooper, R.G. (1998). Benchmarking new product performance: results of the study. *European Management Journal*, 16(1): 1-17.
- De Jong, J.P.J., and Den Hartog, D.N. (2007). How leaders influence employees' innovative behavior, *European Journal of Innovation Management*, 10(1): 41-64.
- Diez, J.M., Ochoa, M.L., Prieto, M.B., & Santidrian, A. (2010) Intellectual capital and value creation in Spanish firms. *Journal of Intellectual Capital*, 11(3):348-367.
- Griffin, A. (1997). Modeling and measuring product development cycle time across industries. *Journal of Engineering and Technology Management*, 14(1): 1-24.
- Hermans, R., and Kauranen, I. (2005). Value creation potential of intellectual capital in biotechnology – empirical evidence from Finland, *R&D Management*, 35(2): 171-185.
- Hsu, L.C., and Wang, C.H. (2012). Clarifying the Effect of Intellectual Capital on Performance: The Mediating Role of Dynamic Capability. *British Journal of Management*, 23(2):179-205.

- Kim, D., and Kumar, V. (2009). A Framework for Prioritization of Intellectual Capital Indicator in R&D. *Journal of Intellectual Capital*, 10(2): 277-293.
- Kazan, H., Pekkanli, B., and Catal, H.V. (2012). Performance Evaluation in research and development, intellectual capital, and firm infrastructure projects as intangible assets. *African Journal of Business Management*, 6(5): 1872-1882.
- Lev, B. (2001). *Intangibles: Management, Measurement, and Reporting*. Washington DC, Brookings (Italian edition *Intangibles*, Etas, Milan, 2003).
- Liao, S.H. and Hu, T.C. (2007). Knowledge transfer and competitive advantage on environmental uncertainty: an empirical study of the Taiwan's industry. *Technovation*, 27: 402-411.
- Meritum (2002). *Measuring intangibles to understand and improve innovation management*. Final Report, European Community, available at: [www.kunne.no/meritum](http://www.kunne.no/meritum)
- Mouritsen, J., Bukh, P.N., Larsen, H.T., and Johnson, T.H. (2002). Developing and managing knowledge through intellectual capital statements. *Journal of Intellectual Capital*, 3(1): 10-29.
- Nejadirani, F., Namvar, F.G., Rasouli, R., and Yadegari, M. (2012). Examining the Effects of Intellectual Capitals Management on Organizational Performance: The Case Study, *Research Journal of Applied Sciences*. *Engineering and Technology*, 4(9): 1040-1050.
- OECD. (2006). *Intellectual Assets and Value Creation: Implications for Corporate Reporting, Organization for Economic Co-operation and Development report*, [Online] Available at: <http://www.oecd.org/daf/corporate-affairs>.
- Panne, G., Beers, C., and Kleinknecht, A. (2003). Success and failure of innovation: a literature review, *International Journal of Innovation and Management*, 7(3): 309-338.
- Pedrini, M. (2007). Human capital convergences in intellectual capital and sustainability reports, *Journal of Intellectual Capital*, 8(2): 346-366.
- Phusavat, K., Comepa, N., Sitko-Lutek, A., and Ooi, K. B. (2011). Interrelationships between Intellectual Capital and Performance, *Industrial Management & Data Systems*, 111(6):810-829.
- Reed, K.K., Srinivasan, N., and Doty, D.H. (2009) Adapting human and social capital to impact performance: some empirical findings from the U.S. personal banking sector. *Journal of Managerial Issues*, 21 (1):36-57.
- Rein, G.L. (2004). From experience: creating synergy between marketing and research and development. *Journal of Product Innovation and Management*, 21 (3):33-43.
- Sanchez, P., Chaminade, C., and Olea, M. (2000). Management of intangibles: an attempt to build a theory, *Journal of Intellectual Capital*, 1 (4):312-327.
- Sullivan, P. H. (2000). *Value-Driven Intellectual Capital: How to Convert Corporate Assets into Market Value*, New York: John Wiley & Sons.
- Taylor, A. (2010). The next generation: technology adoption and integration through internal competition in new product development, *Organization Science*. 21:23-41.
- Tikoria, J., Banwet, D.K., and Deshmukh, S.G. (2010). Measuring the effectiveness of success factors: a case of government funded R&D organizations in India, *International Journal of Business Excellence*, 3(3):279-302.

*Received: March 29, 2016*  
*Accepted: September 24, 2016*