ON CATEGORIES OF FACTORS INFLUENCING THE INNOVATION: AN EMPIRICAL STUDY IN IT SECTOR

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Abstract-Innovation has been one of the most important factors in driving the economic growth in all industries and in particular the IT industry. The innovation will give a competitive edge to a company over the others. But the factors which influence innovation are not understood clearly. Nevertheless there are no proper instruments which measure the performance of innovation owing to the complexity involved in selection of different variables. There are some instruments available for innovation performance measurement but they are not complete. The main thrust of this paper is on the development, validation and application of the categories of factors which influence innovation in the IT sector through empirical means. The instrument that is chosen for the empirical study tests the dependence of innovation in the IT sector on the three dimensions of categories of factors. The instrument is validated for content, criterion and constructs validity, which includes the statistical test of significance. The empirical study has been performed using this instrument through random sampling technique. A hypothesis is tested to study whether different categories of factors influence innovation in IT sector. The result of this empirical study is the development of a valid instrument that can be used to study the influence of categories of factors on innovation in IT sector.

1. INTRODUCTION:

Innovation has long been recognized as an important driver of economic growth (Romer 1990, Grossman and Helpman 1994, Bloom and Van Reenen 2002, Bosworth and Collins 2003). Despite the abundance of empirical findings and the unprecedented interest in innovation, researchers still lack a fundamental understanding of the factors that create innovation and the mechanisms through which innovation creates growth. Perhaps most frustrating has been the failure to find an empirical measure of innovative activity that offers deep insight into the underlying factors and mechanisms. In the flurry of theoretical and empirical investigations, most researchers have used intangible assets and total factor productivity growth as proxies for innovative activities. These studies have consistently shown innovative activities to be a major factor in the economy. For example, Nakamura (2001) estimated investment in intangibles at approximately $1 trillion per year, and Corrado, Hulten, and Sichel (2006) estimated those investments at approximately $1.2 trillion per year. The sheer size of these proxy measures indicates the importance of innovation in driving economic growth, but they do not give enough insight into the underlying mechanisms of how innovation yields growth to advance theories and models of innovation.

So it is very important now to identify and categorize different factors which significantly influence innovation in general and IT sector in particular. The IT sector is highly knowledge intensive and needs to be innovative always. It is also very important to find out whether the different categories of factors significantly influence innovation.

2. LITERATURE REVIEW

Despite the difficulties in measuring innovation, researchers persist in their search for the one true indicator of innovation. Milbergs and Vonortas (n.d.) portrayed innovation metrics as evolving through four generations :
• The *first generation* of metrics reflected a linear conception of innovation focusing on *inputs* such as R&D investment, and the like.
• The *second generation* complemented input indicators by accounting for the *intermediate outputs* of S&T activities.
• The *third generation* focused on a richer set of *innovation indicators and indexes* based on surveys and integration of publicly available data.
• The *fourth generation* metrics of the knowledge-based networked economy remain ad hoc and are the subject of measurement.
Since intangible assets do not exist in physical form, they present a set of difficult measurement problems that arise primarily from the inability to measure intangible assets directly. Researchers are forced to resort to proxies and techniques for indirect measurement. To guide those indirect techniques, researchers have devised a variety of ways to characterize intangible assets. Intangible assets can be divided into three subcategories based on the degree to which they can be controlled and/or sold by the firm (Blair and Wallman 2001):
• Assets that can be controlled and owned by the firm and can be separated and sold, for example, patents and databases.
• Assets that can be controlled and owned by the firm but not separated out and sold, for example, R&D and organizational processes.

• Assets that may not be wholly controlled by the firm and are therefore not owned by the firm, for example, knowledge and skills of labor force.

While intangible assets represent the knowledge and skill sets of the organization, they are the vehicle for integrating knowledge into an innovative product, service, or process.

3. THE MEASUREMENT INSTRUMENT

The literature review has identified that the intangible assets and tangible assets have significant influence on innovation. These intangible and tangible assets can be grouped into different categories depending on their inherent characteristics. The objective of this research is to find out whether the different categories of factors which have significant influence over innovation are dependent or not.

The meta-analysis of available literature has resulted in the identification of the following instruments used for measuring innovation capacity and intangible assets.

a) **Intangible Asset Monitor:** The Intangible Asset Monitor is a framework for measuring intangible assets and knowledge flows using non-monetary metrics (Bontis 2001; Sveiby 1997). It is based on the premise that firms accumulate intangible assets to enable knowledge and tangible inputs to be converted into tangible outputs and financial outcomes.

b) **Skandia Navigator:** Skandia, a Swedish financial and accounting services firm, was the first large company to produce an intellectual capital report as an addendum to traditional financial reports. Numerous other companies have adopted Skandia's methods for measuring and reporting intellectual capital (Bontis, 2001).

c) **IC-dVal:** IC-dVal applies a resource-based view of the firm, in which resources are accumulated and deployed through organizational processes to produce outputs and achieve economic outcomes, to correlate the financial value of intangible assets with economic performance (Bounfour 2003). The IC-dVal focuses on four intangible resources:

d) **Cash Curve:** A cash curve illustrates the cumulative flow of cash throughout the innovation process. It uses cash realized (referred to as payback) as a metric for evaluating the progress and success of the innovation process for a specific product. The cash flow at any point in the innovation process is a function of prior investments, current costs, and real and projected sales revenue (from the product). The cash curve provides estimates of cash flow based on assumptions about technical feasibility and the market.

e) **Technology Factors:** The Technology Factors is a tool for managing intellectual assets and evaluating the productivity of R&D and other activities that generate intellectual capital (Bontis 2001). The use of patents and other forms of intellectual property as proxies for intellectual capital is based on empirical evidence that firms with highly cited patents have higher market value.

Categories of factors

Thus it is understood that innovation is influenced by a series of factors. These factors are complex, nonlinear, multidimensional, and unpredictable. No single measure is likely to characterize innovation adequately in its totality. Further, important aspects of innovation such as knowledge cannot be measured directly. These factors may be related to human resource, organization, business environment etc. Since the innovation not solely depends on tangible assets the role of intangible assets are also very important.

An organization may have best of the R & D infrastructure but the utilization of it is needed to get the best result. This R & D infrastructure should not be meant to reinvent the wheel but to invent something new. The utilization of the R & D is dependent on different intangible factors predominantly the human capital. New ideas must be generated from within and outside the organization and it should not be detrimental to the society. When an organization spends on R & D or invest on new ideas it may so happen that the organization may loose the investment but the organization should be in a position to sustain such investment be able to absorb the loses and further support the innovation. In such cases the size of the organization is very important and can still sustain the growth and invest on innovative ideas.

The leadership and policies of the organization is very important in promoting innovation. The vision and the direction provided by the top management are very important for an organization to be innovative. The organization must be able to identify the market needs and market trends so as to capitalize on it with the innovative products and ideas. Innovation should be really a need for the organizations which wants to stay ahead in the competition to have an edge over the others. Some organization needs to innovate to

come out of the stagnation. Profit motive of the organizations also make them to be more innovative. Thus there are different reasons for which the companies wish to be innovative.

The economic activity of the region is very important to promote the innovation in that region. The buying capacity of the customers and acceptance of it also is helpful in promoting innovation.

Thus there are various factors which influence innovation in the IT sectors. These various factors are needed to be identified and these different factors may also be independent or dependent on other factors. Since most of these factors are non tangible in nature measuring it will be a difficult task. The different tools considered above will not specify the different categories of factors which have significant influence on innovation are dependent or not.

So the intangible and tangible assets are categorized into three categories as given below.

Category I- Factors related to personal characteristics of an employee
Category II- Factors related to organizations
Category III- Factors external to the organization and employee

Category 1: Personal characteristics
Education, Experience, Reluctance from the employees, Professional Capability, Attrition rate, Mobility of employees, Ideas, Inventions, Communication, Team spirit, Recognition, Motivation

In this category personal characteristic of an IT professional has been considered. The professional can be an employee or can be in the management cadre or the promoter of an IT company itself. Some of these personal characteristics may be unique to an individual person but some may be common with all the professionals. Some of the characteristics may be independent and some may be dependent on others. Again magnitude of this dependency and independency varies on different situation. These personal characteristics may also vary depending on the hierarchy in which the professional is in. The quantum of these characteristics also varies from person to person. But these characteristics do have great influence on innovation.

Category 2: Organization
Top Management Strategy, Human Resource/Knowledge Management, Profitability, Investments/funds, Customer Satisfaction, Forecasting the growth, Research and Development, Size of the company, Pace of reaction to the market needs, Market leadership, Diversity of designs, Sales, Interaction among the different departments,

Organizational structure, Product Life cycle, Incentives.

An organization may have its own strength and its own weakness also. Both of these fundamentals depend on many factors. These factors may be dependent or independent of each other. Inherent strength or the weakness of an organization depends not only on the employee but on various other factors. These factors are listed in this category of characteristics. The magnitude of influence of these characteristics on innovation also varies depending on situation and its significance on a given condition. Thus one cannot specify the magnitude of impact of any specific characteristics on innovation but can definitely generalize the quantum of influence. These characteristics are also influenced very much by the personal characteristics.

Category 3: External factors
Competition, Market Trends, Market Needs, Customer Acceptance, Reluctance from the customers, Cost of funds, Changes in Economic Activity, Changes in Technology, Changes in Globalization, Opportunity, Standards, Form factors, Intensity of competition, Number of players in the market, Environment, Culture, Suppliers, Time Frame, Technology, freedom, personalization and computing eco system, Security, Government Policies

There are other characteristics which influence innovation may not be related either to personal characteristics of an IT professional or the characteristics related to the organization. But it can be external to both of the categories. Even if both of the above given categories of characteristics have positive impact the third category may have negative impact on innovation. Like other two categories of characteristics different factors of this third category will have varying degree of influence on innovation. Again the magnitude of influence varies on different scenarios and different conditions. These categories have been developed into self administered questionnaire. This questionnaire is used as the measurement instrument and allows holistic assessment of the category of factors which influence innovation activity of a given organization. Depending on different conditions the influence of different category on innovation will vary. The different categories may have varying degree of influence on innovation. The magnitude of influence varies on different counts. Again the magnitude of influence also depends on the category which is being considered on a given situation. Influence of different categories also varies on different scenario. Some of the factors of a category may have different perceptions in different situations. So the magnitude of influence of a category on innovation depends on

the factors whose influence varies on different situations.

The degree of influence may vary from minimum-moderate-maximum. Since each of the categories has different factors in it, influence of each factor will contribute its share to the total influence of each category. When the influence of the category is considered it is the total influence of different factors is considered and not the sole influence of any factors. Influence of different factors of a category also varies on different conditions. Some of these variables of a category are dependent and some are independent. The dependency of a variable on another variable varies in different scenario. Even the independent variables level of influence on innovation is not fixed.

In some conditions the tangible assets play a major role on innovation and in some other cases the intangible assets. Thus again the innovation is not just dependent on tangible and intangible assets but it is the combination of the both. So the organizations can not just invest more on one kind of assets that is tangible or intangible and there should be balance between the two kinds. The proportion of these two kinds of asset is also not the same in all situations and again depends on various factors. Understanding this complex relationship between the different kinds of tangible and intangible assets and the kind of influence these have on innovations is also very important to know which kind of right situations may lead to innovation. But knowing the right situation is also important to get the correct mix of investment on tangible and intangible assets.

In some situations tangible assets play major role and in some situation intangible assets play a major role in innovation. Again the life cycle of the organization in which it is at present also play an important role innovation. There are many companies which are in its initial stage of life cycle innovate and create some kind of ripples in the market through their innovations and will become the market leaders in their segment in the later stage of their life cycle for example Apple, Microsoft, Google, Face Book etc. These companies will move through different stages of their life cycle from initial stage to become the established companies but all these will happen through continuous innovation. There are numerous companies which could not innovate will die down in the initial stages of their life cycle itself and do not move to the next level of life cycle. The successful companies that have already in their advanced stage of life cycle have to continuously innovate to keep the edge over the others. The role of tangible and intangible asset is not the same during different stages of life cycle of a company. For the companies which are in their initial stages of life cycle intangible assets play a major role over tangible. For example companies like Apple, Microsoft, Google, Face Book

etc. are the brain child of their founders where the intangible asset of the founders like knowledge, attitude, motivation, ideas etc. have played a major role in innovations. When the companies are in their later stages of life cycle it is not only the intangible but also the tangible asset play a major role in innovation. The position of the company is able to attract more talent who can be offered different kinds of incentives to get the best out of them and retain them too. Through the acquisition routes also the established companies can buy the potential companies which have the capabilities of producing innovative products. The smaller companies which have been sold also get the much needed support of intangible and tangible assets. Since companies which have bought those companies are in the advanced stage of life cycle they can consolidate their positions by innovations being generated by the newly acquired companies.

4. RESEARCH METHODOLOGY:

The sampling unit comprise IT Sector (Software development and Services organizations). The IT Sector is highly knowledge intensive and needs to be innovative always. The sample selection is through random sampling technique. The data collected is through self administered questionnaires that measure the performance effectiveness rating of the three categories. The questionnaire were served to the employees (different levels) of different companies, out of which 131 responses were received back (return rate of 60%) after repeated follow up. However, we could select only 127 entries, as others were incomplete.

The data is processed through Microsoft Excel 2003 for statistical analysis. The processed data is presented in table 4.1 and figure 4.1, 4.2 and 4.3. The empirical study consists of Chi-Square test for independence of attributes in a contingency table. The following hypothesis is tested in this research.

We formulate the Hypothesis H_0: Categories and their influence on Innovation are independent. Vs H_1: They are dependent.

Table below gives the influence of different identified categories on Innovation

Table 4.1

	Maximum effect on innovation	Moderate effect on innovation	Minimum effect on innovation	
Category 1	33	07	09	49
Category 2	25	08	09	42
Catego	12	14	10	36

ry 3				
Colum n Total	70	29	28	127

Category 1: Influence of factors related to personal characteristics on innovation
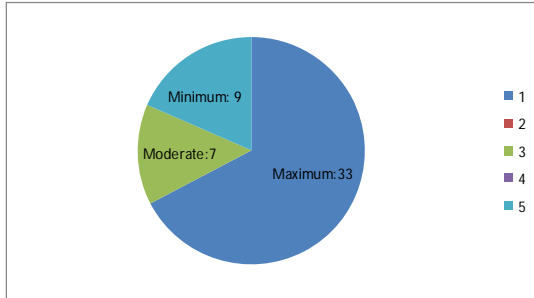

Fig. 4.1
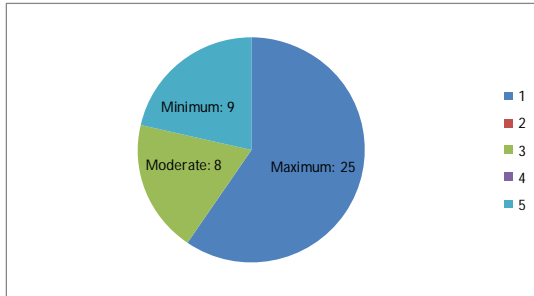**Category 2: Influence of factors related to organization on innovation.**

Fig. 4.2
Category 3: Influence of external factors of business to the organization and employee on innovation.
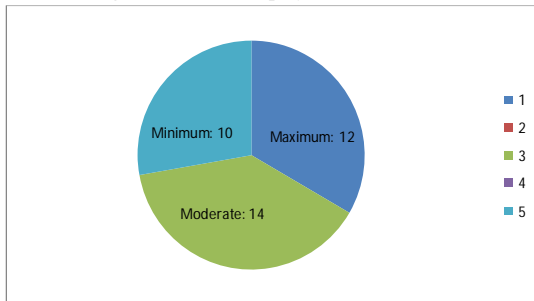

Fig. 4.3

5. RELIABILITY, VALIDITY AND PRACTICALITY OF THE MEASUREMENT INSTRUMENT

Sound measurement must meet the tests of Reliability, Validity and Practicality. These are the three major considerations used in a research, which involves data collection through instruments such as questionnaires (Kothari, 2000).

The chi-Square test is an important test amongst the several tests of significance developed by statisticians. Chi-Square test symbolically written as $\chi2$ test (pronounced as Ki-Square), is a statistical measure used as a nonparametric test, it "can be used to determine if categorical data shows dependency or the two classifications are independent. It can also be used to make comparison between theoretical populations and actual data when categories are used. Thus chi-Square test is applicable in large number of problems. The test is, in fact, a technique through the use of which it is possible for all researchers to (i) test the goodness of fit (ii) test the significance of association between two attributes and (iii) test the homogeneity or the significance of population variance. A common approach used in literature to study the independence of attributes is through Chi-Square test of independence of attributes in a contingency table. The categorized data is represented in a 3X3 contingency table (table no.4.1) and then the above test is applied on it. Here we use this test to test whether the Categories and the influence on innovation are independent (Kothari, 2011).

Practicality of the measurement instrument was evaluated in terms of economy, convenience and interpretability. More items in a questionnaire will give greater reliability (Kothari, 2000) but this is tedious and time consuming. Because of this a limited numbers of items with a maximum of three categories were used in the questionnaire of this research.

6. DATA ANALYSIS AND FINDINGS

The table value of $\chi2$ for 4 degree of freedom at 5 percent level of significance is 9.488, and the calculated value of $\chi2$ is 11.31694

Since the calculated value is in the Critical region we reject H_0. In other words it may be concluded that the effect on Innovation depends on the categories.

7. CONCLUSION

Innovation in the IT sector has become an important factor for driving this knowledge intensive sector into new heights. But unless these organizations develop an effective measurement instrument to evaluate the performance of innovation, to find whether different categories of factors significantly influence innovation there would be a possibility of loss in productivity and performance and it may adversely affect the return on investment. The literature review has identified that the intangible and tangible assets have significant influence on innovation and has also revealed that measuring of influence of tangible and intangible assets on innovation in terms of revenue generation is difficult and it is not the same always for same set of tangible and intangible assets and again it differs depending on different conditions. Identification of different tangible and intangible asset is an important task. Once these have been identified it is not necessary that they are applicable in the same way in all situations. Some of the factors

which make up tangible assets may be independent or dependent on other factors. Similarly there may be dependency between the some of the factors which are part of intangible assets and some may be altogether independent. These dependency and independency may again vary on different situations. The quantum of dependency is also not the same all the time and again it may vary during different scenario.

Magnitude of influence of tangible and intangibles assets also vary during the different stages of establishment of an organization. In some stages some of the factors which make intangible assets play a major role and in some cases it is the factors of intangible assets. When there are different factors which influence innovation segregating these factors into different group also a challenging task. Once these factors are grouped these have to be properly categorized into different categories. The factors identified are categorized according to different properties of these factors. The properties of the factors of a group should share some common values.

The statistics have shown that different levels of employees have varying perception about the categories which have significant influence on innovation. According to this perception all these categories have various levels of influence on innovation. In each of the categories the respondents have also stated their perception about the quantum of influence of each of the category on innovation. Thus the respondents have indicated that the influence of each category varies from minimum to moderate to maximum on innovation. Thus again it is the scenario which impress upon the respondents to judge the quantum of influence of a category on innovation. These different scenarios can be related to the tangible or intangible assets. The quantum of influence of tangible and intangible assets may also vary depending on the stage of life cycle in which the company is located at present. Since each of these categories is composed of different factors, each of the factors contribute to varying degree of influence on innovation and the perception of the respondents about the influence of each of the factors on innovation contributes to their view about the kind of influence a category has on innovation.

This empirical study was carried out to provide a valid instrument to find whether different categories of factors significantly influence innovation. A further study on how the different characteristics of

intangible and tangible assets influencing innovative on IT sector is in progress. This paper has developed, validated and tested an innovation measurement tool which tests the different categories of factors which significantly influence the innovation in IT sector. There is a scope to further develop this questionnaire to include more number of items to suit the specific requirement of a typical organizational set-up. This tool can also be applied to any kind of industry as the basic components of innovation remain the same. This paper has resulted in the development of one such measurement tool which will readily find the relationship between the different categories of factors which significantly influence innovation.

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