Determinants of innovation as a competence: an empirical study

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Abstract: This paper posits that innovation as a competence generic from individuals and the environment in which they are engaged. It focuses on individuals by proposing a method for measuring innovation as a competence. It is postulated here that innovation as a competence involves a set of competencies such as: visioning, ability to generate ideas, internal and external networking relationship, ownership to the organisation, stretch mindset, focus on tasks and decision making. However, these competencies are determined by gender, age, reading habits and educational background of individuals, etc. It is attempted here to construct an empirical model and analyse the impacts of the determining parameters on innovation as a competence. The empirical analysis suggests significant differentiating determinants. The study has been carried out in an Indian information technology company. The findings may facilitate human resource decision making relating to competency management.

Keywords: innovation as a competence; information technology industry; human resource development; empirical research; ordinal logistic regression; business innovation and research.

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1 Introduction

It has been argued that the success of today's businesses increasingly depends on their intellectual assets, as opposed to their tangible resources (Stewart, 1997; Sveiby, 1997). Among other things, these assets include attitude, knowledge and skills of the workforce. According to American Society for Training and Development (ASTD), these assets are known as competencies. They are areas of personal capability that enable people to perform successfully in their jobs by achieving outcomes or completing tasks effectively. When companies explicitly define the competencies they need, and also provide the tools for assessing those competencies in their employees, then they can more easily and objectively manage people. Several organisational disciplines have attempted to find ways to leverage these assets. From a strategic management point of view, the question has been how organisations are able to use these assets to secure a persisting competitive advantage (Mohanty, 1999). Individual competence has been seen as an important ingredient in the mix of a company's systems, technologies, physical location and infrastructure that make up this competence. Therefore, managing individual competencies is one important element in the management of strategic competitive advantage. Strategic management research has usually not focused on concrete instruments that deal with the measurement of individual competencies. Traditional human resource management (HRM) instruments (such as job analysis, selection, training and development, etc.) have been in use in organisations for years. However, their use has recently been criticised for neglecting the strategic connection. It has also been questioned whether these instruments are able to cope with the new productivity challenge in the knowledge-based economy, namely to enhance the productivity of the knowledge workers who now make up a large share of the workforce (Elkjaer, 2000). More recently, knowledge management has introduced new perspectives. Being driven by innovative information technology (IT) applications, the goal has been to enhance

access, sharing, use and creation of knowledge in organisations. However, just providing employees with a better access to available information or to communication channels has not always produced better outcomes. Instead people's ability to make use of and apply knowledge they are generating is becoming a key issue. Michellone and Zollo (2000) argue that "the very paradox of knowledge is that firms possess knowledge only if they are able to transform it, and the primary ability to transform knowledge resides in people and their competencies". It appears that academia and practitioners have struggled with the question of how to better leverage human competencies in organisations. They have approached the question from different perspectives and have used different techniques to deal with it. And they all have limitations as well.

Innovation has been an important competence of individuals. The purpose of innovation is to create business value. That value can take many different forms, such as incremental improvements to exist products, the creation of entirely new products and services, reducing costs, etc. Drucker (1995, 2001) emphasises that every organisation needs one core competence: innovation. It is important to measure innovation. Drucker further stresses that every organisation needs a way to record and appraise its innovative performance. Mohanty (2006) outlined that for an economy or a nation to achieve pre-eminent position and superior status, it has to pioneer the culture of innovation. The reason we want to do this is because we want our enterprise to survive, and to grow, and in a rapidly changing market the only way to do either is to innovate effectively. In the history of business, it is clear that the effective innovators have a better chance of surviving, and non-innovators tend not to survive at all. The method of innovation is to develop ideas, refine them into a useful form and bring them to fruition the market where they will hopefully achieve profitable sales or in the operation of the business where they will achieve increased efficiencies.

Amabile (1996) defines innovation as the successful implementation of creative ideas within an organisation. Tidd et al. (2001) says that innovation is a process of turning opportunity into new ideas and of putting them into widely used practice. Heller (2001) identifies that competence information is a critical diagnostic tool needed to effectively manage a business. Bharadwaj (2000) points out that the core competency depends on competence of individuals and the organisational systems. Our study of literature reveals that innovation processes and their interplay with other business processes in organisations have been well researched. However, we have observed that there is a paucity of research studies relating to the factors affecting innovation as a competence of an individual.

In this paper, we propose a construct for measuring innovation as a competence of an individual. It comprises of visioning, ability to generate ideas, internal and external networking relationships, ownership to the organisation, stretch mindset, focus on tasks and decision-making competencies. Further, there are various controllable and uncontrollable determinants, such as gender, age, education, quality of best idea and reading habits, etc.

2 Review of literature

In recent years, there has been a considerable interest in the academia analysing innovation and organisational change (Anand et al., 2007). There is a very vast amount of literature, which has generated significant interest in identifying how companies can

improve their innovative activity and what factors have positive effects on such behaviour. Based on the resource-based view (RBV) of the firm, researchers have proposed that the crucial research question concerns what kinds of corporate resources lead to sustainable competitive advantages. Following these arguments, the types of employee knowledge, skills and abilities (KSA) have been considered key resources for the improvement of existing products and services or for the generation of new ones (innovations), which, by extension, help to achieve competitive advantages (Nonaka and Takeuchi, 1995; Thompson, 2003). Further, it has been argued that there must be coherence between an organisation's HRM practices and the strategies that it adopts, and this requirement would also be applicable to an innovation strategy (Kang et al., 2007). We have made a comprehensive review of the current state-of-the-art on innovation as a human resource competence and have identified the important determinants, which are described briefly in the following sections.

2.1 Diversity in knowledge and networking of relationship

Hargadon (2003) demonstrates that innovations are a result of synthesising ideas from different fields. He argues that it is the result of simultaneous thinking in multiple boxes and not of the oft-prescribed 'thinking outside of the box'. Dyer et al. (2009) says that associating, questioning, observing, experimenting and networking are important skills for an individual to be innovative. Johansson (2006) suggests continuously expanding value network as a key factor. Lafley and Charan (2008) assert that anyone can innovate, but practically no one can innovate alone. Hansen and Birkinshaw (2007) point out that the key metric to keep in mind is diversity, and not the mere number of contacts. Bessant et al. (2009) suggest that individuals should not limit their searches to fields they are already familiar with but instead look at the edge of their radar screens and sometimes a bit beyond. Hansen and Birkinshaw (2007) and Johansson (2002) express similar thoughts. Bharadwaj and Menon (2000) have used reading habits as an input to decide innovation performance of an individual. McDonough et al. (2006) investigated the global product development effort of an international organisation and established criticality of social networks and social capital that is leveraged to access knowledge as vital for innovation. Miller et al. (2007) have proven that searching for and transferring knowledge across divisions in a diversified firm can cultivate innovation. Mors (2010) has studied global consulting firms and found out that partners operating in homogeneous contexts, where the primary challenge is to access diverse information, benefit from low-density networks. In contrast, when crossing both firm and geographic boundaries, partners with dense networks have higher innovation performance. Leiponen and Helfat (2010)'s empirical study suggest that broader horizons with respect to innovation objectives and knowledge sources are associated with successful innovation. Zhou and Wu (2010) have established that while technological capability fosters exploitation at an accelerating rate, it has an inverted U-shaped relationship with exploration. That is, a high level of technological capability impedes explorative innovation.

2.2 Age and gender

Frosch (2007) has established that the share of younger academic workers has a significant positive effect on patenting output (significance levels between 1% and 5%). Schneider (2007) has studied the trend of an ageing workforce on the innovation

capacities by using an empirical approach based on an ordered-logit regression model. He discovered significant age effects on firm's innovation potential. The estimated age-innovation-profile follows an inverted U-shaped pattern, peaking at the age of about 40 years. Millward and Freeman (2002) found that innovative solutions are attributed more often to male managers.

2.3 Myers-Briggs Type Indicator

The Myers-Briggs Type Indicator (MBTI) assessment is a psychometric questionnaire designed to measure psychological preferences about how people perceive the world and make decisions (Myers and Myers, 1995). It is the most widely used personality assessment tool and is validated by many researchers (O'Hara et al., 2006; Quenk et al., 2001; Schaubhut et al., 2008). Even so, some psychologists have criticised the instrument for lack of convincing validity (McCrae and Costa 1989; Stricker and Ross, 1964).

Hipple et al. (2001) found that although MBTI profiles of innovators varied significantly, they followed some patterns. He found that the NT (N stands for Intuition and T for thinking) was the largest two-attribute combination. On the other hand, Kroeger and Theussen (1992) have established that STJ (S for sensing, T for thinking and J for judging) is the most common pattern amongst the senior corporate managers. This study coupled with Kirton (1984) analysis illustrates that a typical innovation champion is very comfortable with substantive change and operates to a significant degree on intuition. This creates several major, potential conflict areas between the innovators and senior corporate managers.

2.4 Innovation diffusion

While innovation starts with the creative thinking of an individual; its further evolution and growth are social process. Rogers (2003) says that diffusion does not happen by fiat but through a well thought and cumbersome process. It requires opening up of the development process to external world. Dyer et al. (2009) points out that the innovators are bound to face criticism and they need to discern constructive ones from others. Munshi (2009) asserts that, innovators not only have to constantly enrol numerous stakeholders and gatekeepers but also infect them so that they become champions of the diffusion process. The innovators also require a strong sense of character for battling and overcoming impediments. Hipple et al. (2001) concludes that both idea generation and diffusion require different skills but have one thing in common. They require more of leadership and facilitation as against management and control.

3 Research design

Although, some research work are available on evaluating and measuring competencies and human behaviour, very little work exists on evaluating innovative competence of an individual (Ethiraj et al., 2005; Marston, 1928; McGrath et al., 1995; Morgan, 2004). Broadly, the research focuses more on intuitive findings and qualitative inferences. This study introduces an approach in innovation competency measurement and which rests on the central idea of connecting individual's innovation competencies to basic determinants such as gender, age, background, reading habits, etc. The purpose of this study is to

inform researchers as well as practitioners in competency management what really are the significant determinants of innovation as a competence and how can be used to support work integrated development and performance management. Research design is a very important step to outline the plan and structure of issues to be investigated and is defined by Malhotra et al., (2002) and Kothari (1999). This study has used the design based on their work and is represented in Figure 1

3.1 Objective, scope and type

Our objective is to find impact of the determinants on individual's innovation competence. As innovation is universal, we had to decide appropriate segment for our study. The basic criteria for the decision were criticality of innovation in that segment and availability of the required data.

We opted for IT sector for our study. While progress of the technology has been remarkable, its true potential is far from realised (Gomes and Kruglianskas, 2009). Moreover, it faces many significant challenges in its application, which have to overcome sooner than later (Charette, 2005). One needs to rely on innovation to take care of both these aspects. Berman (2005) has pointed out that the US information industry had the largest annual growth of 5.7% from 1994 to 2004 and has forecasted to have the second largest growth of 5.2% from 2004 to 2014.

Figure 1 Research design process (see online version for colours)

In the IT sector, Indian industry has demonstrated unprecedented success as it grew from USD 2B to USD 52B in the last decade. The industry has become critical to the global customers that include 75% of Fortune 500 companies (NASSCOM and McKinsey, 2009). Therefore, we took a sample of a large Indian IT organisation to validate our construct.

We have adopted descriptive and diagnostic type of research design. Descriptive design details the existing state of affairs and do not control any variables. Diagnostic research studies determine the frequency with which something occurs and is concerned with the case as well as the treatment. The research studies are classified as cross sectional and longitudinal studies. We have adopted the former as we have taken a snapshot of the measurements. Our research is conducted in real-life situations and, therefore, is a field-setting statistical study.

3.2 Selection of instruments

This is a critical step as it maps research problems to a mathematical domain. We had to accomplish ways to measure both, the response variables i.e. innovation as a competence and explanatory variables i.e. determinants.

We found that the company under study has one of the well-designed performance management systems and decided to use it for measuring the competence. Andrews (1999) and Sethi et al. (1999) have established that the judgements of managers and customers on creativity are highly correlated. We formed a focus group to study various competencies in the system and chose the following as reflection of two aspects of innovation – *Fresh Thinking* and *Value Creation* as depicted in Figure 2.

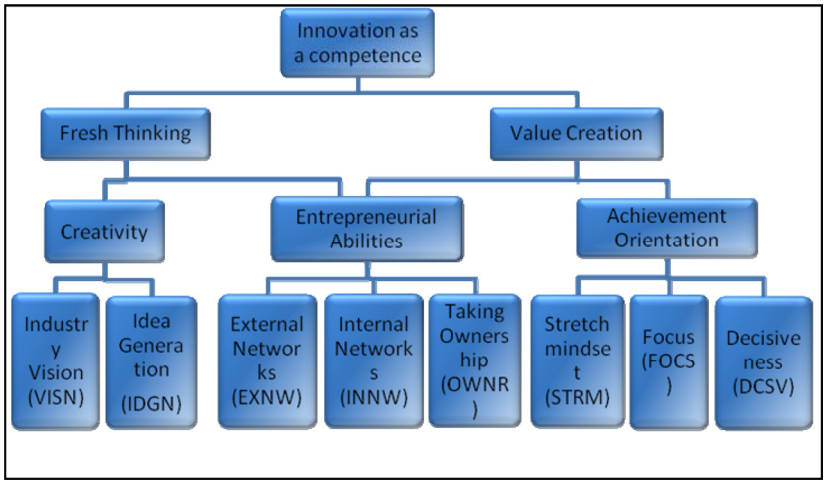
Creativity: the performance management system has subdivided creativity into industry vision and idea generation competencies. Amabile (1988) argues that innovation in an organisation is significantly influenced by the extent of creativity-relevant skills possessed by its employees. Bresciani (2009) has established the relationship between creativity and innovation within firms in the Piedmont area. Yao, et al. (2010) based on their study of Chinese employee in diverse industries found that creativity was positively linked to innovation behaviour. Thus, creativity is one of the vital requirements for bringing in fresh thinking.

Entrepreneurial abilities: this is further subdivided into internal networking, external networking and taking ownership. This competency is required for both, fresh thinking and value creation. Dyer et al. (2009), Johansson (2006), Lafley and Charan (2008), Hansen and Birkinshaw (2007) and Bessant et al. (2009) have emphasised the role of diversity and networking, while Dyer et al. (2009) and Munshi (2009) have pointed out criticality of ownership for innovation.

Achievement orientation: this is classified into stretch mindset, focus and decisiveness and it is required for value creation (Dyer et al., 2009; Munshi, 2009; Rogers, 2003).

We sought the basic information regarding educational qualifications, best ideas and reading habits from the respondents and relied on the personnel records for gender and age.

Figure 2 Innovation competence measurement frameworks (see online version for colours)



To understand reading habits, we asked the number of engineering and management books/journals the respondents read every year. They had to choose one of the three options – less than 2, between 2 and 5 and more than 5. We also elicited their interests in the school days on constant sum (of 10) scale in various areas besides reading. Further, we enquired about their current hobbies. We used the following heuristic to decide the reading habits.

- More than 5 books per year either in technology or managerial areas, interest in reading in school days greater than or equal to 2, and reading figuring in hobbies were rated as avid readers.
- Less than 2 books per year in both technology and managerial categories, interest in reading in school days equal to 0 and reading not figuring in hobbies were rated as apathetic readers.
- Others were rated as medium readers.

We had asked the respondents to list their best ideas. We evaluated all the ideas with the help of three independent and blind reviewers. They rated the ideas in four classes: *A*, *B*, *C* and *N*. Here, *N* stands for not an idea. The classes were assigned marks as 5,3,2,0, respectively. We added all the scores and individuals who scored more than ten were taken as the best idea generators and who scored less than four were considered as the worst idea generators. The rest were classified as medium idea generators.

In case of age, we divided the population in four quartiles. The four quartiles of the age groups are less than 35, 35–37, 37–41 and greater than 41.

The educational background was categorised as science graduates, commerce graduates, engineering graduates, management graduates and engineering graduates with management degrees.

As the response and explanatory variables are not collected from the same respondent, common method bias issue did not arise.

3.3 Sampling

Our population for this study is mid level managers who typically have experience of more than 10 years. Any organisation innovates at three levels – strategic, tactical and operational. The strategic management level is engaged in policy innovations and enterprise modelling. The tactical levels, which are represented by middle managers, are engaged in products, processes and system innovations, which provide durable foundations to the strategic level and operational guidelines to the operating level. The managers at the middle level focus on engaging in a distributed network or team formed inside the IT organisation that takes on the role of much of the innovation work. Individuals connected to the network generate their own ideas, conduct experiments, log the results, build support and help transition some of the ideas to formal pilots or direct implementation. The networks employ features from several different morphologies characterised by different determinants and use some principles from natural selection to recombination/reengineering and improve ideas throughout the organisational business processes. Further, they are accountable for attaining the business goals and enjoy considerable amount of freedom in decision making and pursuing as well as driving initiatives. This population has also been subjected to competency mapping for the last few years. Purposive sampling has been adopted and the sampling frame consists of the mid level managers from the selected IT organisation.

3.4 Collection of data

The pre-testing was carried out in three stages. In the first stage, a draft of the questionnaire was provided to two academicians. They critically evaluated the questionnaire from the standpoint of item specificity, clarity of construction and usage for statistical computation. The second pre-test involved administering the questionnaire to a set of senior managers. They were asked to complete the questionnaire and indicate any ambiguity or other difficulty they experienced in responding to the items, as well as to offer any suggestions they deemed appropriate. The third pre-test involved administering the questionnaire to around 50 mid level managers. After this, the questionnaire was finalised to make the final research instrument more valid.

The data have been collected from the personal records of the company and the questionnaire has been administered to all individuals ($N = 552$). However, we got only responses from ($n = 441$). As discussed earlier, we used data from performance management system to measure innovation competence.

3.5 Reliability assessment

It is important to conduct a thorough measurement analysis on the survey instrument. It provides assurance that the findings reflect accurate measures and the results are trustworthy. Test reliability indicates the extent to which individual differences in scores can be attributed to 'true' differences in the characteristics under consideration. We have used Cronbach alpha to assess the reliability of performance management data. The corresponding values are provided in Table 1.

Since alpha values for all the factors are found to be equal to or greater than 0.70, the questionnaire used here is judged to be reliable (Nunnally, 1978). Some of the basic information such as gender, age and education were uncontrollable determinants and we

have not performed any reliability analysis for the same. For other predicates, we considered two random sets of 50 points and checked that their means are within the respective standard deviations as given in Table 2.

Table 1 Cronbach alpha value for various competencies

Competency group	*Alpha value*
Creativity competencies	0.7453
Entrepreneurial leadership competencies	0.7321
Achievement orientation competencies	0.7715

Table 2 Reliability assessment of predicates using two sets of 50 random samples

	Sample 1		*Sample 2*	
Area	*Mean*	*SD*	*Mean*	*SD*
Best idea	3.82	3.231	3.8	3.245
Reading technology	0.76	0.6468	0.62	0.753
Reading managerial	0.76	0.847	0.76	0.971
Reading as hobby	0.58	0.4986	0.68	0.4712
Reading as a school activity	2.1	1.015	2.04	1.212

4 Analysis of data and interpretation

Statistical studies are designed for breadth rather than depth. They intend to capture characteristics of a population by formulating inferences from characteristics of a sample.

4.1 Impact of creative competencies on other competencies

We have verified that creative competencies are weakly correlated with many of the value creation competencies as showed in Figure 3. We have used Kruskal stress diagram, the earliest and most popular multidimensional scaling technique. It visualises dissimilarity of data by representing objects as points in a two dimensional space, such that the distances between the points match the observed dissimilarities as closely as possible. (Kruskal, 1964a,b). The closer ones are strongly correlated. We can see that IDGN–VISN–EXNW and INNW–FOCS–STRM–OWNR are closely related groups. These are broadly creativity and idea diffusion competency groups and are weakly correlated with each other.

Meredith Belbin and his team conducted research, over a period of nine years. The team studied the behaviour of managers from all over the world and has come up with distinct nine roles/competencies (Belbin, 2004). To validate the findings, we analysed the Belbin score of over 100 managers across various industrial organisations. Even then, we found the similar pattern; creativity competencies are weakly correlated with execution competencies. This is depicted in Figure 4. It can be observed that complete finisher (CF), monitor evaluator (ME) and implementation (IMP) competencies are placed quite far from idea generation (PL), shaper (SH) and resource investigator (RI) competencies.

Figure 3 Kruskal's stress diagram for various innovation competencies (see online version for colours)

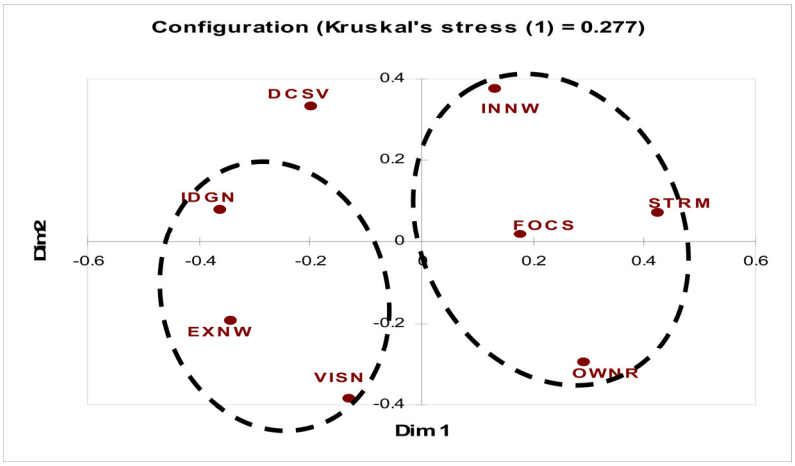
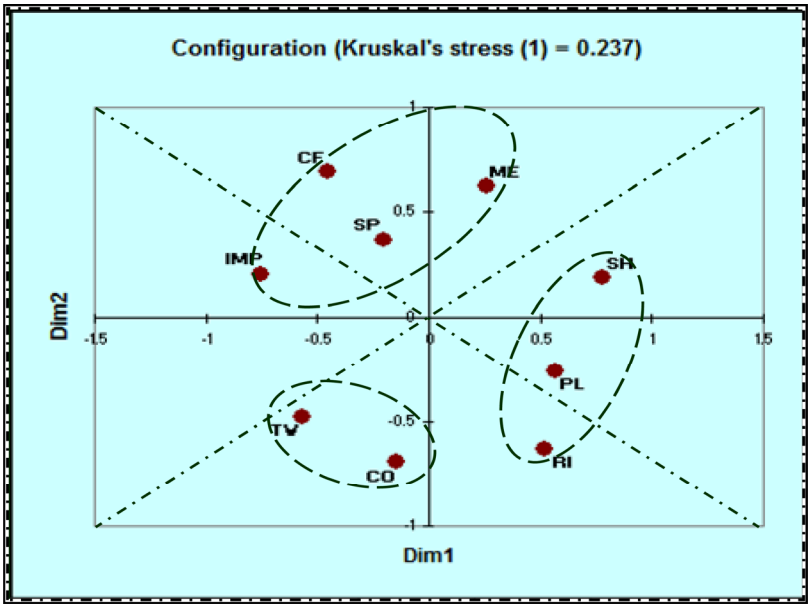


Figure 4 Kruskal's stress diagram for Belbin score (see online version for colours)



Note: PL, plant; RI, resource investigator; CO, coordinator; SH, shaper; ME, monitor evaluator; TW, team worker; IMP, implementer; CF, completer finisher; SP, specialist.

4.2 Determinants affecting innovation as a competence

Chi-square test determines association between explanatory and response variables and is applied in various situations (Jie et al., 2008; Liu et al., 2009; Melanie, 2004; Yong, 2009). Many researchers use the parametric methods, such as ANOVA (Munez, 1998) to determine the extent of association even in case of ordinal response variables. They either ignore the ordinal characteristics of data (Gould, 2002) or apply some transformations (Harveson and Rush, 2002). While Lawson and Montgomery (2006) has implemented this method for analysing customer satisfaction, Rusch et al. (2004) has applied it to trace the impact of AIDS on various activities of patients. Kim (submitted) has used it for analysing fire ant data.

We analysed the impact of gender, age, educational background, reading habits and best idea on innovation as a competence in two steps. First, we performed chi-square analysis and wherever chi-square exhibited stronger association, we used the ordinal logistic regression analysis.

4.2.1 Chi-square analysis for all eight response variables

Table 3 comprises various determinants in the first column and response variables in the subsequent columns. The individual cells contain *p*-value of the chi-square analysis. We have considered strong associations for values less than 0.10. These values are highlighted with italic in the respective cells.

4.2.2 Ordinal logistic regression

As discussed earlier, wherever chi-square indicates stronger association, ordinal logistic regression analysis is performed. We have used odds ratio (also referred to as odds) to determine extent of impact of explanatory variables on the response variables. The 'odds' of an event is defined as the probability of the outcome event occurring divided by the probability of the event not occurring. The 'odds' for a predictor is defined as the relative amount by which the odds of the outcome increase (odds greater than 1.0) or decrease (odds less than 1.0) when the value of the predictor variable is increased by 1.0 units.

Table 3 Chi-square analysis for all competencies

Determinants	*VISN*	*IDGN*	*OWNR*	*INNW*	*EXNW*	*STRM*	*FOCS*	*DCSV*
Gender	*0.075*	0.186	0.491	0.418	*0.096*	*0.010*	0.732	0.402
Age	0.473	*0.003*	0.519	0.326	0.265	*0.067*	0.576	*0.102*
Quality of best idea education	*0.054*	0.213	0.14	0.72	0.496	0.524	0.373	0.67
Engg and mgmt	0.116	0.575	0.545	0.34	0.921	0.702	0.793	0.838
Commerce and science graduates	0. 868	0.524	0.239	0.374	*0.054*	0.193	0.553	0.521
Commerce and science graduates and engg and mgmt graduates	0. 158	0.221	*0.086*	0.47	*0.024*	*0.034*	*0.043*	*0.053*
Reading habits	*0. 003*	*0.022*	0.302	*0.064*	0.303	0.378	0.263	0.184

4.2.2.1 Gender Chi-square has shown dependency in case of industry vision, external networking and stretch mindset. The outcome of the ordinal logistic regression analysis for the three competencies is given in Table 4.

From the results, we conclude that the odds of getting better rating for male managers are 1.62 times more in case of industry vision and 1.82 times more in case of external networking. Millward and Freeman (2002) established that innovative solutions were attributed more often to male managers.

4.2.2.2 Age Dependency in case of idea generation, stretch mindset and decisiveness is predominantly observed. The outcome of the ordinal logistic regression analysis for the three competencies is given in Table 5.

For idea generation, the odds of quartile 4 age group getting lower ratings are 2.67 times more. In case of stretch mindset, the odds of getting a lower competency rating increase with age. The odds are at their maximum value for the fourth quartile. Additionally, when we consider decisiveness, the odds of quartile 4 age group getting lower ratings are 1.89 times more. Simonton (2000) research supports that individuals must develop in depth domain expertise to be creative. He, however, found that creativity increases with years devoted to the field, reaches a maximum, and after which it tapers off. Gardner and Policastro (1999) have found out that the tapering starts after ten years. Given that our quartiles of the age groups are less than 35, 35–37, 37–41 and greater than 41; our finding are in line with the above.

Table 4 Ordinal logistic regression analysis for gender and industry vision, external networking and stretch mindset

	Industry vision	*External networking*	*Stretch mindset*
Test that all slopes are zero: *p*-value	0.093	0.032	0.043
Goodness-of-fit tests *p*-value for Pearson and Deviance	0.145 and 0.147	0.962 and 0.962	0.040 and 0.033
p-Value and odds ratio	0.086 and 1.62	0.032 and 1.82	0.047 and 1.78
Model usability[a]	Ok	Very good	Not good

[a]The model is usable if, test that all slopes are zero: *p*-value is closer to zero and goodness-of-fit tests *p*-value for both Pearson and Deviance require are away from zero.

Note: Base – male managers.

Table 5 Ordinal logistic regression analysis: age and idea generation, stretch mindset and decisiveness (base 1st quartile)

	Idea generation	*Stretch mindset*	*Decisiveness*
Test that all slopes are zero: *p*-value	0.006	0.056	0.068
Goodness-of-fit tests *p*-value for Pearson and Deviance	0.239 and 0.233	0.830 and 0.828	0.192 and 0.173
p-Values and odds ratios for Q2, Q3, Q4	(0.210, 1.40), (0.240, 1.37), (0.001, 2.67)	(0.168, 1.150), (0.099, 1.63), (0.007, 2.28)	(0.766, 1.91), (0.281, 1.33), (0.013, 1.89)
Model usability	Good	Very good	Ok

4.2.2.3 Quality of best idea There is dependency in case of vision. Its logistic regression is given in Table 6.

It is not viable to draw any conclusion, as the model is not usable. Possibly some respondents have hesitated to share their best ideas.

4.2.2.4 Education We carried out this study in three parts:

- *Part 1*: we traced the difference between engineer, manager (without engineering qualifications) and engineer managers. There was no association between these combinations.
- *Part 2*: we considered commerce and science graduates. This combination has a good association in external networking. Ordinal logistic regression analysis as depicted in Table 7.

In this competency, odds of commerce graduates scoring better are quite high. We believe that the students, who are unsuccessful to acquire admission for medical and technological courses, end up choosing the science courses. Science, not being their first choice they perhaps end up scoring poor in external networking.

- *Part 3*: we also studied difference in commerce and science graduates together with engineering and management graduates. There is a clear dependency in ownership, external networking, stretch, focus and decisiveness. The ordinal logistic regression for them is as given in Table 8.

Table 6 Ordinal logistic regression analysis: quality of best idea and vision

	Industry vision
Test that all slopes are zero: *p*-value	0.112
Goodness-of-fit tests *p*-value for Pearson and Deviance	0.123 and 0.122
p-Values and odds ratios	(0.041, 0.60) and (0.310, 0.61)
Model usability	Not good

Note: Base – worst idea generators.

Table 7 Ordinal logistic regression analysis for education and external networking

	External networking
Test that all slopes are zero: *p*-value	0.002
Goodness-of-fit tests *p*-value for Pearson and Deviance	0.148 and 0.140
p-Values and odds ratios	0.002 and 3.36
Model usability	Good

Note: Base – commerce graduates.

Table 8 Ordinal logistic regression analysis for education and ownership, external networking, stretch, focus and decisiveness

	OWNR	*EXNW*	*STRM*	*FOCS*	*DCSV*
Test that all slopes are zero: *p*-value	0.200	0.533	0.029	0.080	0.107
Goodness-of-fit tests *p*-value for Pearson and Deviance	0.086 and 0.086	0.007 and 0.007	0.212 and 0.212	0.099 and 0.102	0.091 and 0.092
p-Values and odds ratios	0.193 and 0.74	0.523 and 1.16	0.027 and 0.58	0.076 and 0.65	0.103 and 0.68
Model usability	Not good	Not good	Good	Not good	Not good

Note: Base – science and commerce graduates.

Table 9 Ordinal logistic regression analysis for education and industry vision, idea generation and internal networking

	Industry vision	*Idea generation*	*Internal networking*
Test that all slopes are zero: *p*-value	0.001	0.022	0.011
Goodness-of-fit tests *p*-value for Pearson and Deviance	0.257 and 0.244	0.389 and 0.388	0.767 and 0.765
p-Values and odds ratios	(0.001, 0.46) and (0.008, 0.30)	(0.006, 0.54) and (0.587, 0.78)	(0.680, 0.90) and (0.009, 0.46)
Model usability	Good	Good	Very good

Note: Base – apathetic readers.

With the above derivations, we conclude that in case of stretch mindset, the odds of engineering and management graduates scoring better ratings are 1.72 times more. In case of ownership, focus and decisiveness, the models are not so good so we are not concluding anything.

4.2.2.5 Reading habits There is a clear association between vision, idea generation and internal networking. The ordinal logistic regression output for the parameters is as given in Table 9.

This brings to light many interesting observations. As reading becomes better, industry vision improves. The odds ratio of avid readers having better vision rises to 3.3. In case of idea generation, there is obvious indication that medium readers are better than apathetic readers with the odds ratio 1.85. On internal networking, avid readers are better with odds ratio of 2.17. These findings reasonably match with Chen et al. (2008). He has established that firms that have better learning orientation score better on innovation. Intellectual capital, or knowledge (Nahapiet and Ghoshal, 1998), is an important part of a global innovation network. It consists of individual and group-level knowledge (Spender, 1986). And its creation in global innovation is crucial which is directly impacted by reading habits.

5 Concluding remarks

Literature is replete with research on effect of the organisational systems and deplete with that of individuals on innovation. We have covered the depleted component by developing measurement for innovation as a competence. Based on data from an IT organisation and the various organisations across different sectors, we conclude that creativity and value creation competencies are in dissonance with each other. Further, we have established the impact of some determinants on innovation as a competence and summarised the same in Table 10. The first column lists determinants and subsequent columns indicate their impact on various competencies. We observed no impact of best idea. Similarly, there was no impact of any determinant on ownership and focus competencies. We have provided the odds ratio for all instances of impact.

From the empirical results, the following propositions may be derived:

- the odds of avid readers faring better in industry vision, internal networking and idea generation are quite high
- the odds of younger managers faring better for idea generation, stretch mindset and decisiveness are higher
- the odds of male managers faring better on industry vision and external networking are high.

This research has the following implications:

It is no secret that the best-conceived innovation purposes and most thoroughly developed innovation processes cannot succeed without the appropriate human resources to execute them. Thus, the innovation as a competence of people effort must be applied and managed correctly. Companies are needed to create dedicated, diverse innovation teams. These consist of individuals acting within the charter of the innovation competencies and determinants. Those teams, which are the most diverse according to the governing determinants represented generally may be the most creative and generate the largest quantity of new ideas. This system should be tailored to a company's specific industry and internal needs and character. But every executive intend on surviving and thriving through innovation should adopt this approach to grow an innovative mind-set at every level of his or her organisation.

Table 10 Summary of Impact of Determinants on Competencies – odds in favour of base class

	VISN	*IDGN*	*INNW*	*EXNW*	*STRM*	*DCSV*
Gender (base class – male)	1.62			1.82		
Age (base class – younger)		2.67			2.28	1.89
Education (base class – commerce				3.36		
Education (base class – engg/mgmt graduates)					1.72	
Reading (base class – avid reader)	3.33	1.85	2.17			

This empirical research study reveals that, a very little attempt has been made to evaluate and provide systematic knowledge about the innovation as a competence. Traditionally, innovation as an organisational phenomenon has been evaluated on a number of factors that have had an impact on organisational performance. This has led to the inappropriate alignment of organisational mission to individual performance contributions. We strongly argue here that innovation, as a competence of individuals is the pivotal to organisational competitive advantage. Therefore, it is desirable that effective framework should be developed so that long-term corporate performance is improved. This survey should be viewed as an attempt towards the attainment of such a goal.

We have not studied interplay of various parameters such as age and education, reading habits and gender, etc. That can be studied. MBTI score and influence of process frameworks such as Altshuller's TRIZ (Smith, 2007), ENGAGE (Chang, 2008) also deserve attention. The factors, such as geography, culture, business area of operation, size of organisation, etc. would impact the innovation competence to certain extent and can be studied.

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References

Amabile, T. (1996) *Creativity in Context*. New York: Westview Press.

Amabile, T. (1988) 'A model of creativity and innovation in organizations', *Research and Organizational Behavior*, Vol. 10, pp.123–167.

Anand, N., Gardner, H.K. and Morris, T. (2007) 'Knowledge-based innovation: emergence and embedding of new practice areas in management consulting firms', *Academy of Management Journal*, Vol. 50, No. 2, pp.406–428.

Andrews, J. (1999) 'Curbing meaningless variety: factors that affect the development of meaningful line extensions', Working Paper, Indiana University.

Belbin, R.M. (2004) *Management Teams: Why They Succeed or Fail* (2nd ed.). Oxford: Butterworth Heinemann.

Berman, J.M. (2005) 'Industry output and employment projections to 2014', *Monthly Labor Review*, Vol. 128, p.11.

Bessant, J., Möslein, K. and Stamm, B.V. (2009) 'In search of innovation', *Wall Street Journal/MIT Sloan*. Available at: http://sloanreview.mit.edu/executive-adviser/articles/2009/2/5123/in-search-of-innovation. 22 June 2009.

Bharadwaj, S. and Menon, A. (2000) 'Making innovation happen in organizations: individual creativity mechanisms, organizational creativity mechanisms or both?' *Journal of Product Innovation Management*, Vol. 17, pp.424–434.

Bresciani, S. (2009) 'Innovation and creativity within firms: an empirical demonstration in the Piedmont area', *Int. J. Business Innovation and Research*, Vol. 3, No. 4, pp.427–443.

Chang, C.M. (2008) 'Engaging the creative minds – the engage models', *Int. J. Innovation and Technology Management*, Vol. 5, No. 1, pp.149–165.

Charette, R. (2005) 'Why software fails', *IEEE Spectrum*, Vol. 42, No. 9, pp.42–49.

Drucker, P. (1995) 'The information executives truly need', *Harvard Business Review*, Prod. #: 95104-PDF-ENG, pp.54–62.

Drucker, P. (2001) *The Essential Drucker*. Oxford: Butterworth Hienemann.

Dyer, J., Lindsay, J., Gregersen, H. and Garber, C. (2009) *How Do Innovators Think?* Available at: http: blogs.hbr.org/hbr/hbreditors/2009/.../how_do_innovators_think.htm.

Elkjaer, B. (2000) 'Learning and getting to know: the case of knowledge workers', *Human Resource Development International*, Vol. 3, No. 3, pp.343–359.

Ethiraj, S.K., Kale, P., Krishnan, M.S. and Singh, J.V. (2005) 'Where do capabilities come from and how do they matter? A study in the software services industry', *Strategic Management Journal*, Vol. 26, pp.25–45.

Frosch, K. and Thusnelda, T. (2007) 'Age, human capital and the geography of innovation', *Conference on Patent and Innovations, Econometrics Studies Strasbourg*, FR. Available at: http://www.wiwi.uni-rostock.de/fileadmin/Institute ... pdf/wp071thuenen.pdf.

Gardner, H. and Policastro, E. (1999) 'From case studies to robust generalizations – an approach to the study of creativity', in R.J. Sternberg (Ed.), *Handbook of Creativity*. Cambridge University Press, pp.213–225.

Gomes, C.M. and Kruglianskas, I. (2009) 'Management of external sources of technological information and innovation performance', *Int. J. Innovation and Technology Management*, Vol. 6, No. 2, pp.207–226.

Gould, J. (2002) *Concise Handbook of Experimental Methods for Behavioral and Biological Sciences*. Boca Raton, Fl: CRC Press.

Hansen, M.T. and Birkinshaw, J. (2007) 'Innovation value chain', *Harvard Business Review*, June, pp.121–130.

Hargadon, A. (2003) 'How breakthroughs happen', *Harvard Business Review*.

Harveson, R.M. and Rush, C.M. (2002) 'The influence of irrigation frequency and cultivar blends on the severity of multiple root diseases in sugar beets', Publication No. D 2002 0528 01R, The American Phytopathological Society, Vol. 86, No. 8, pp.901–908.
Heller, R. (2001) *Peter Drucker – The Great Pioneer of Management Theory and Practice* (3rd ed.). London: Dorling Kindersley Ltd., pp.201–220.

Hipple, J., Hardy, D., Wilson, S.A. and Michalski, J. (2001) *Can Corporate Innovation Champions Survive*. American Chemical Society Publications, November, pp.15–22.

Jie, O., Nilesh, P. and Ishwar, S. (2008) 'Chi-square test based decision tree induction in distributed environment', *Data Mining Workshops*, December, pp.477–485.

Johansson, F. (2006) *The Medici Effect*. Boston, Massachusetts: Harvard Business School Press.

Kang, S-C., Morris, S.S. and Snell, S.A. (2007) 'Relational archetypes, organizational learning, and value creation: extending the human resource architecture', *Academy of Management Review*, Vol. 32, No. 1, pp.236–256.

Kim, H.S. (2004) 'Topics in ordinal logistic regression and its applications', PhD Dissertation, Office of Graduate Studies of Texas A&M University.

Kirton, M.J. (1984) 'Adaptors and innovators: why new initiative get blocked', *Long Range Planning (UK)*, Vol. 17, No. 2, pp.137–143.

Kothari, C.R. (1999) *Research Methodology: Methods and Techniques*. New Delhi: Vishwa Prakashan, pp.21–151.

Kroeger, O. and Thuessen, J. (1992) *Type Talk at Work*. New York: Dell Publishing, pp.394–399.

Kruskal, J.B. (1964a) 'Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis', *Psychometrika*, Vol. 29, pp.1–27.

Kruskal, J.B. (1964b) 'Nonmetric multidimensional scaling: a numerical method', *Psychometrika*, Vol. 29, pp.115–129.

Lafley, A.G. and Charan, R. (2008) *The Game Changer*. New York: Crown Business.

Lawson, C. and Montgomery, D.C. (2006) 'Logistic regression analysis of customer satisfaction data', *Quality and Reliability Engineering International*, Vol. 22, pp.971–984.

Leiponen, A. and Helfat, C. (2010) 'Innovation objectives, knowledge sources, and the benefits of breadth', *Strategic Management Journal*, Vol. 31, No. 2, pp.224–236.

Lee, C-K., Tan, B. and Chiu, J-Z. (2008) 'The impact of organizational culture and learning on innovation performance', *Int. J. Innovation and Learning*, Vol. 5, No. 4, pp.413–428.

Liu, Y., Wang, H., Guo, X., Liang, Z. and He, Q. (2009) 'A comparison between inside and outside texture features extracting from pulmonary nodules of CT images', *Fifth International Conference on Natural Computation, ICNC*, Vol. 6, pp.183–186.

Malhotra, N.K., Hall, J., Shaw, M. and Oppenheim, P. (2002) *Marketing Research: An Applied Orientation* (2nd ed.). Sydney: Pearson Education.

Marston, W.M. (1928) *Emotions of Normal People*. New York: Harcourt, Brace and Company, Cooper Press.

McCrae, R.R. and Costa, P.T. (1989) 'Reinterpreting the Myers-Briggs Type Indicator from the perspective of the five-factor model of personality', *Journal of Personality*, Vol. 57, pp.17–40.

McDonough III, E.F., Athanassiou, N. and Barczak, G. (2006) 'Networking for global new product innovation', *Int. J. Business Innovation and Research*, Vol. 1, Nos. 1/2, pp.9–26.

McGrath, R.G., MacMillan, I.C. and Venkataraman, S. (1995) 'Defining and developing competence: a strategic process paradigm', *Strategic Management Journal*, Vol. 16, No. 4, pp.251–275.

Michellone, G. and Zollo, G. (2000) 'Competencies management in knowledge-based firms', *Int. J. Technology Management*, Vol. 20, Nos. 1/2, pp.134–155.

Miller, D., Fern, M. and Cardinal, L. (2007) 'The use of knowledge for technological innovation within diversified firms', *Academy of Management Journal*, Vol. 50, No. 2, pp.308–326.

Millward, L.J. and Freeman, H. (2002) 'Role expectations as constraints to innovation: the case of female managers', *Creativity Research Journal*, 1532-6934, Vol. 14, No. 1, pp.93–109.

Mohanty, R.P. (1999) 'Value innovation perspective in Indian organizations', *Participation and Empowerment: An International Journal*, Vol. 7, No. 4, pp.88–103.

Mohanty, R.P. (2006) 'Intrapreneurial levers in cultivating value-innovative mental space in Indian corporations', *Vikalpa*, Vol. 31, No. 1, pp.99–105.

Morgan, M. (2004) *Innovation: More to it Than Meets the Eye*. Australia: Keeping Good Companies, Chartered Secretaries.

Mors, M. (2010) 'Innovation in a global consulting firm: when the problem is too much diversity', Available at: http://dx.doi.org/10.1002/smj.837.

Munshi, P. (2009) *Making Breakthrough Innovation Happen*. India: Harper Collins Publishers.

Munzel, U. and Bandelow (1998) 'The evaluation of Parametric verses non parametric tests in the statistical evaluation of rating scale', *Pharmacopsychiatry*, Vol. 31, pp.222–224.

Myers, I. and Myers, P.B. (1995) *Gifts Differing: Understanding Personality Type*. Mountain View, CA: Davies-Black Publishing.

Nahapiet, J. and Ghoshal, S. (1998) 'Social capital, intellectual capital, and the organizational advantage', *Academy of Management Review*, Vol. 23, No. 2, pp.267–284.

NASSCOM and McKinsey (2009) *NASSCOM 'Perspective 2020'*. India: NASSCOM.

Nonaka, I. and Takeuchi, H. (1995) *The Knowledge Creating Company*. UK: Oxford University Press.

Nunnally, J.C. (1978) *Psychometric Theory*. New York: McGraw Hill, p.701.

O'Hara, J.M., Thompson, R.C., Donnay, D.A.C., Morris, M.L. and Schaubhut, N.A. (2006) 'Correlating the newly revised strong interest inventory® with the MBTI®', Poster presented at *the American Psychological Association Annual Conference*, New Orleans, LA.

Quenk, N.L., Hammer, A.L. and Majors, M.S. (2001) *MBTI® Step II Manual*. Mountain View, CA: CPP, Inc.

Rogers, E. (2003) *The Diffusion of Innovation* (5th ed.). Free Press.

Rusch, M., Nixon, S., Schilder, A., Braitstein, P., Chan, K. and Hogg, R.S. (2004) 'Impairments, activity limitations and participation restrictions: prevalence and associations among persons living with HIV/AIDS in British Columbia', *Health and Quality of Life Outcomes*, Vol. 2, p.46.

Schaubhut, N.A., Thompson, R.C. and O'Hara, J.M. (2008) 'The influence of personality of where people choose to work', Poster presented at *the Annual Convention of the American Psychological Association*, Boston, MA, August, pp.14–17.

Schneider, L. (2007) 'Alterung und technologisches Innovations potential – Eine Linked-Employer-Employee-Analyse', IWH-Discussion Papers, January.

Sethi, R., Smith, D. and Park, C.W. (1999) 'The effect of cross-functional teams on the innovativeness of new consumer products', Working paper.

Simonton, D.K. (2000) 'Creativity: cognitive, developmental, personal and social aspect', *American Psychologist*, Vol. 55, No. 1, pp.151–158.

Smith, H. (2007) 'How companies develop operating systems for innovation', CS White Paper.

Spender, J.C. (1986) 'Making knowledge the basis of a dynamic theory of the firm', *Strategic Management Journal*, Vol. 17, pp.45–62.

Stewart, T.A. (1997) *Intellectual Capital: the New Wealth of Organizations*. New York: Doubleday, p.240.

Stricker, L.J. and Ross, J. (1964) 'An assessment of some structural properties of the Jungian personality typology', *Journal of Abnormal and Social Psychology*, Vol. 68, pp.62–71.

Sveiby, K.E. (1997) *The New Organizational Wealth*. San Francisco: Berrett-Koehler.

Thompson, L. (2003) 'Improving the creativity of organizational work groups', *Academy of Management Executive*, Vol. 17, No. 1, pp.96–111.

Tidd, J., Bessant, J. and Pavitt, K. (2001) *Managing Innovation: Integrating Technological, Market and Organizational Change* (2nd ed.). Chichester: John Wiley & Sons Ltd.

Yao, X., Yang, Q., Dong, N. and Wang, L. (2010) 'Moderating effect of Zhong Yong on the relationship between creativity and innovation behavior', *Asian Journal of Social Psychology*, Vol. 13, pp.53–57.

Yong, L. (2009) 'Applications of chi-square test and contingency table analysis in customer satisfaction and empirical analyses', *2009 International Conference on Innovation Management (ICIM 2009)*, pp.105–107.

Zhou, K. and Wu, F. (2010) 'Technological capability, strategic flexibility, and product innovation', *Strategic Management Journal*, Vol. 31, pp.547–561.