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An Empirical Study of Interdependency among the Identified Innovation Factors

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ABSTRACT

Innovation is the need of the hour for an organization to stay ahead of the competition. It's a critical factor that can make or break an organization's success. The factors influencing innovation, whether tangible or intangible, are complex and multifaceted. The factors that drive innovation need further research as proper tools are unavailable to determine the quantum of influence the factors have on innovation. Building on their previous research, the authors identified key factors that significantly influence innovation through a comprehensive literature review. This study, however, took a different approach, conducting an empirical investigation using a survey as a measuring tool. The study then performed statistical analysis on the data, identifying and shortlisting the factors that play a crucial role in driving innovation within an organizational context. The study employed a statistical analysis, including a large sample z-test for proportions and hypothesis testing for each of the 25 factors. This approach led to the shortlisting of 13 factors that significantly influence innovation. Furthermore, the study used Correlation analysis to understand the interdependency among the innovation factors, adding another layer to the research. Further research may be directed toward devising a mathematical model for the innovation index for use as a measuring tool to assess an organization's innovation potential.

Keywords: Innovation; Interdependency; Technology; Competition; Organizational Structure

INTRODUCTION

Innovation is recognized as an important driver of economic growth (Romer, 1990; Grossman & Helpman, 1994; Grönlund et al., 2010; Bloom & Van Reenen, 2002; Bosworth & Collins, 2003). Despite exceptional interest and plenty of empirical outcomes, researchers still need to understand the factors that create innovation and how innovation creates growth. An empirical measure of innovative activity that clearly explains these mechanisms and factors has yet to be developed.

Innovation is generally the result of out-of-the-box thinking by people motivated to create something different and new. This thinking differently may lead to bringing out a new product or a change in the service or process that is carried out routinely. In the course of innovation management, restructuring and changes in the technological front may be required. Innovation generates a new idea and "brings it to the market." It is imperative that innovation should lead to add value and should have a positive influence on society.

While business efficiency is a crucial aspect of any enterprise, it alone cannot sustain competition and growth. On the other hand, innovation is a vital driver of revenue growth and wealth creation. In today's business landscape, strategic planning is significantly influenced by an organization's innovation capability, highlighting the economic potential of innovative work.

As studies have shown, competition and demand are key drivers of innovation. Unless used in the public domain, an invention remains beneficial only to the inventor. However, when an invention creates new or improved products, services, and processes that are useful to society and significantly alter how things operate, it is termed innovation.

As in today's competitive landscape, survival is only possible with innovation, this has become the cornerstone of any organization's success and profitability. Keeping this in mind, the primary purpose of this empirical research is to examine the factors that influence innovation in organizations and the level of interdependency among them.

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The study is organized into five sections. The introductory section offers a broad perspective on the study, setting the stage for the subsequent sections. The second section thoroughly examines the pertinent literature, comprehensively understanding the factors influencing organizational innovation. Section three outlines the research methodology. Section four offers valuable insights into the methods employed and the results obtained, contributing to the empirical findings of the research. Finally, the concluding section summarizes the key findings from the study, providing a deeper understanding of the implications and significance of the findings. In addition, this section presents the future scope of the study.

LITERATURE REVIEW

Innovation, a complex and multidimensional activity, cannot be measured with a single indicator or directly (Milbergs, 2004). Its success hinges on a multitude of factors that complement each other. This intricate nature of innovation, with its complex multiplicity feature, cannot be adequately captured with a single measurement. The market's demand dictates the rate of investment and the release of new products, a crucial driver of innovation.

It's a well-established fact that both tangible and intangible factors play a significant role in innovation. However, the influence of intangible assets, which are not present in physical form, is not straightforward to measure. This necessitates the use of indirect measurement options, leading to the formulation and characterization of substitution methods.

Japanese success in technology and science is predominantly due to its citizens' creative attitude and high-level education (Dauda, 2010). Sternberg and Lubart's (1999) 'Investment Theory' suggests that the inclination to innovate requires converging several characteristics, such as personality, thinking styles, intellectual abilities, knowledge, motivation, and environment.

"Geneplore" and the "Componential" replica give the significant of research at the personal echelon, and earlier scholarly articles can be segregated into the link between innovation and six features: personality, knowledge, cognitive ability, behavioral abilities, motivation, emotion and mood states.

Although researchers have tried to find any dependency between intelligence and innovation capabilities, they have yet to reach a conclusive finding. Most of the scholarly articles in this scope can be segregated into four categories, envisaging innovation:

1. General Intelligence
2. A Tinge of Geniuses
3. Mental Processes and Cognitive Abilities
4. Intelligence judged by the observer

A summary of the characteristics that may positively influence innovation is provided in Figure 1.

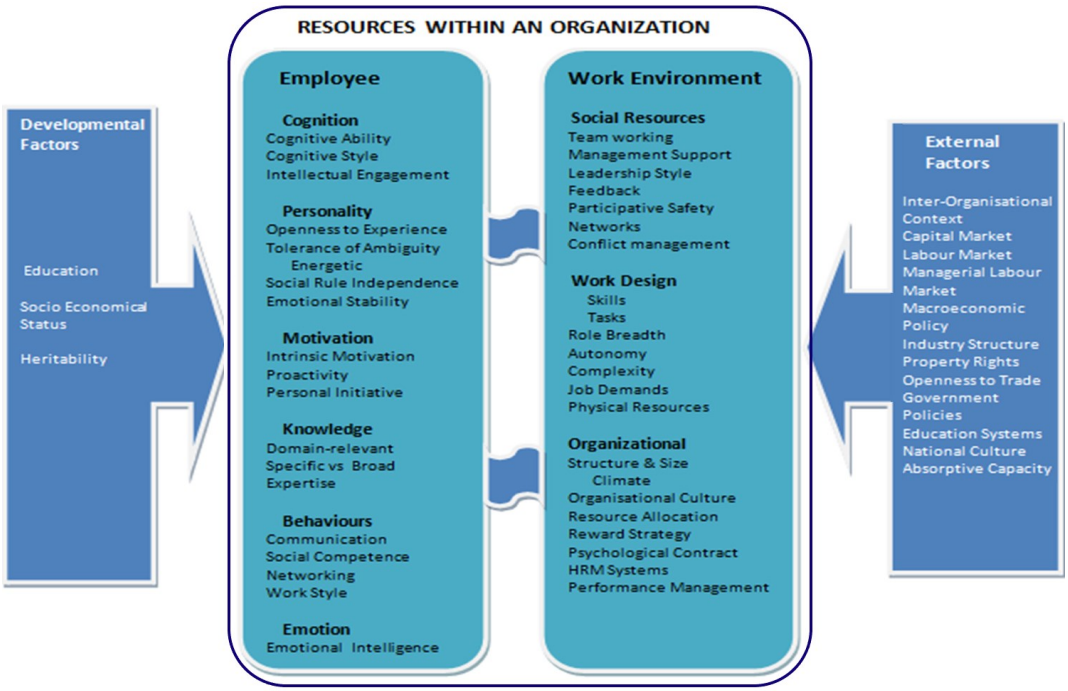

Figure 1: Innovation in organization: People pertinent resources for innovation in organizations (Patterson et al., 2009).

Simon (1991) suggests that the learning process in organizations involves both existing and newly employed members, as the new members may bring knowledge previously unavailable in the organization. An organization's innovative edge is significantly determined by the skills and knowledge of its employees (Nelson & Winter, 1985). Education contributes to building an individual's expertise, which may be presented through drawings, books, articles, presentations, and others. However, a good education is not the principal component of building an enhanced individual knowledge level.

Acha et al. (2007) and Loasby (2002) point out that the more an employee enhances his knowledge in his specialization, the more the organization benefits. Therefore, employee knowledge must be enhanced across their functional areas. Knowledge gained and accumulated through working experience is tacit, as gaining it is not only due to education. This tacit knowledge is difficult to formalize or communicate (Polanyi, 1966; Nonaka et al., 1994; Nonaka & Takeuchi, 1995). The advantage of an individual's tacit knowledge is proved during the actions and activities undertaken while working on a specific task or project. Practical knowledge is the basic foundation of tacit knowledge (Nelson & Winter, 1985). In the view of Nonaka et al. (1994) and Nonaka and Takeuchi (1995), the dominant forces that motivate individuals to enhance their knowledge are their intention and freedom in the given environment. Thus, individuals are the starting point and significant source contributing to organizational knowledge and learning.

The significant factors contributing to learning and innovation in organizations include education and training, communications among departments, creative thinking, a platform to showcase expertise, intentions and freedoms, and intensity of efforts. Therefore, organizations need a suitable positive working environment for all the above processes.

Patterson et al. (2000) emphasize individual initiative, social proficiency, and proactivity as contributors to employee behaviors associated with innovation. Studies have indicated that extrinsic rewards and the most needed intrinsic motivation may contribute to innovation. These include bonuses, pay increases, recognition, awards, and promotions (Abbey & Dickson, 1983; Eisenberg & Thompson, 2011).

According to Manso (2011), innovation that needs to be tested earlier is likely to fail, and relating failure to pay hikes or having a negative impact on career growth will hamper the innovative environment in the organization. Instead, a robust, tolerant approach to failure and some reward for having the intention to contribute to innovation will substantially help the organizations achieve long-term success.

According to Patterson et al. (2009), such organizations are most active in bringing about innovation, which positively promotes and compensates the individual or team responsible for innovation. Organizations that devote time to brainstorming sessions to showcase their employees' creative ideas also successfully promote innovation.

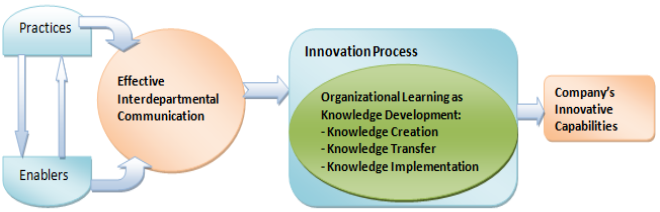

Figure 2: Conceptual framework for interdepartmental communication (Kovalenko, 2009)

Organizations need to learn to be successful in innovations, and there are different ways to learn (Bessant & Tidd, 2007). These happen through R&D, ideas acquired from outside the organization, interactions with suppliers, partners, and customers, and reviewing the documents of previous projects.

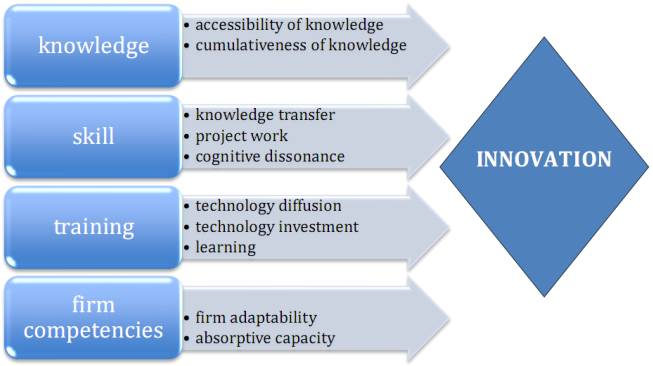

Figure 3: A model of interlinkages between components of skill systems and innovation (Jones & Grimshaw, 2012)

RESEARCH METHODOLOGY

Our study, grounded in a comprehensive literature review, has identified 25 distinct factors that shape innovation. These factors, both tangible and intangible, are complex and multidimensional. The degree of influence each factor exerts on innovation varies, adding further nuance to our understanding.

This empirical study, a collaborative effort with the Information Technology (IT) industry, was made possible by the valuable insights of IT professionals. Their perceptions about the influence of each factor on innovation were crucial to our understanding.
The study analyzed the responses from 1,023 IT professionals from 213 representative IT companies with the help of a large sample z-test for proportion. Further, the study tested the hypothesis for the influence of each of the 25 factors on innovation. Based on the result of the hypothesis, which was dependent on the outcome of the z-test performed on the responses received for each of the 25 factors, the factors that significantly influence innovation were filtered. Thus, 13 factors have been filtered to influence innovation significantly. Further, using a correlation analysis, the study examined interdependency among these 13 innovation factors. One factor was compared with all the other factors to arrive at the inference.

RESULT AND FINDINGS

Analysis of the Responses

After repeated follow-ups, we received 1,213 responses to the Survey Form distributed to IT professionals. However, we could select only 1,023 entries, as others were incomplete. These respondents work in 213 different companies.

Large Sample Test for Proportions

A large sample z-test for proportions was conducted on the responses received to see which factors significantly influence innovation.

The equation calculates the Z value for each factor. A significant proportion of 70 percent is considered positive and is, hence, accepted for the analysis.

$$Z = \frac{\hat{P} - P}{\sqrt{\frac{P \times Q}{n}}}$$

Hence, H0: P = P0 Vs. H1: P > P0, where P is the proportion of respondents who opined positively towards the influence of the specific factor on innovation in the population, i.e., P0 = 0.7 and n is the sample size which is 1,023. We reject H0 if the calculated value of Z > Zα, where α is the level of significance and the value of Zα can be obtained from the tables of the area under the standard normal distribution, and it is 1.64.

For each factor, we formulated a hypothesis H0: P = 0.7 Vs. H1: P > 0.7 and concluded that the parameter significantly influences innovation if H0 is rejected, where P is the proportion of respondents who opined positively about the influence of the specific factor on innovation in the population.

Table 1 presents the 13 factors where the null hypotheses were decisively rejected, underscoring their significant influence on innovation.

Table 1: List of the key factors

Factor	Name of the factors
A1	Experience of an employee influences the innovation
A2	Attitude of an employee influences innovation
A3	Team spirit of an employee triggers innovation
A4	Incentives motivate employees to be more innovative
A5	Working with other innovators promotes innovation
A6	Organizational structure influences the innovation level of employees
A7	Freedom to experiment given in the workplace contributes to the innovative skills of an employee
A8	The support for R & D promotes innovation
A9	Regular training for the employees enhances their innovative skills
A10	Free Environment promotes innovation
A11	The opportunity influences innovation
A12	Intense competition influences innovation
A13	The technology change necessitates innovation

Interdependency between Identified Key Factors

According to the statistical analysis of the data received, 13 factors influence innovation in the IT sector. The study analyzed the interdependency among these innovation factors.
Correlation analysis was used to understand the interdependency among the innovation factors. Accordingly, one factor was compared with all the

other factors, and the results are tabulated as shown in Table 2.
The correlation coefficient value of 0.3 is considered a cut-off value for checking the relationship between the key factors.

Table 2: Interdependency between the key factors

Fact--ors	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
A1	1.000												
A2	0.120	1.000											
A3	0.265	0.282	1.000										
A4	0.297	0.148	0.286	1.000									
A5	0.183	0.190	0.169	0.133	1.000								
A6	0.206	0.148	0.152	0.221	0.166	1.000							
A7	0.160	0.125	0.156	0.097	0.155	0.303	1.000						
A8	0.176	0.092	0.165	0.068	0.192	0.306	0.519	1.000					
A9	0.284	0.071	0.237	0.234	0.366	0.092	0.107	0.132	1.000				
A10	0.119	0.222	0.163	0.163	0.475	0.180	0.234	0.165	0.359	1.000			
A11	0.216	0.149	0.164	0.154	0.273	0.151	0.155	0.130	0.212	0.239	1.000		
A12	0.141	0.106	0.187	0.156	0.179	0.136	0.147	0.183	0.125	0.120	0.263	1.000	
A13	0.251	0.107	0.116	0.186	0.222	0.228	0.306	0.320	0.197	0.149	0.307	0.243	1.000

As shown in Table 2, the critical factors "experience of an employee influences the innovation" (A1), "attitude of an employee influences innovation" (A2), "team spirit of an employee triggers innovation" (A3), and "incentives motivate employees to be more innovative" (A4), had no robust relationship between the other factors. Whereas the key factor, "working with other innovators promotes innovation" (A5), had a stronger relationship with the key factors, "regular training for the employees enhances their innovative skills" (A9) (r = 0.366) and "free environment promotes innovation" (A10) (r = 0.475). Similarly, the factor "organizational structure influences the innovation level of employees" (A6) had a good relationship with "freedom to experiment given in workplace contributes to the innovative skills of an employee" (A7) (r = 0.303), and "the support for R & D promotes innovation" (A8) (r = 0.306).

The key factor, "freedom to experiment given in workplace contributes to the innovative skills of an employee" (A7), had a better relationship between "the support for R & D promotes innovation" (A8) (r = 0.519), as well as a good relationship between "the technology change necessitates innovation" (A13) (r = 0.306). Similarly, the critical factor "the support for R & D promotes innovation" (A8) has a more substantial relation to the factor "the technology change necessitates innovation" (A13) (r = 0.320). The critical factor, "regular training for the employees enhances their innovative skills" (A9), shows a good relationship between the factors, "free environment promotes innovation" (A10) (r = 0.359).

As Table 2 shows, the key factor "free environment promotes innovation" (A10) does not show any relationship between the other key factors except "working with other innovators promotes innovation" (A5). The factor "the opportunity influences innovation" (A11) has a good relationship only with "the technology change necessitates innovation" (A13) (r = 0.307). In contrast, the critical factor "intense competition influences innovation" (A12) has no relationship with any key factors.

Overall, the key factors "experience of an employee influences innovation," "attitude of an employee influences innovation," "team spirit of an employee triggers innovation," "incentives motivate employees to be more innovative," and "intense competition influences innovation" do not show any relationship between any of the key factors.

Figures 4, 5, and 6 compare A1 and A2, A6 and A7, and A11 and A12 respectively.

A comparison between the key factors, "experience of an employee enhancing his innovation skills" and "attitude of an employee influences innovation," is graphically represented in Figure 4. As shown, among the respondents who strongly agreed that the "experience of an employee enhances his innovative skills," 299 strongly agreed, 130 moderately agreed, and 28 were neutral about the critical factor "attitude of an employee influences innovation." Similarly, among the respondents who moderately agreed that the "experience of an employee enhances his innovative skills," 179 strongly agreed, 109 moderately agreed, and 51 were neutral about the key factor "attitude of an employee influences innovation."

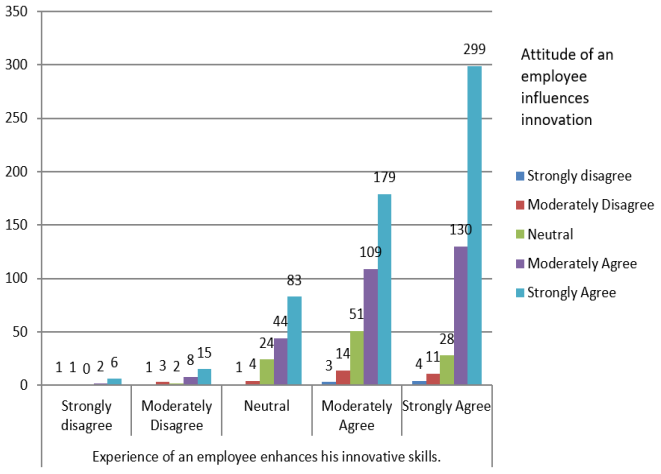

Figure 4: Chart comparing "experience of an employee" and "attitude of an employee enhancing innovation skills"

A comparison between the key factors, "organizational structure influences the innovation level of an employee" and "freedom to experiment in the workplace contributes to the innovative skills of an employee," is graphically represented in Figure 5. As shown, among the respondents who strongly agreed that "organizational structure influences the innovation level of an employee," 339 strongly agreed, and 50 moderately agreed about the critical factor "freedom to experiment given in workplace contributes to the innovative skills of an employee." Similarly, among the respondents who moderately agreed that "organizational structure influences the innovation level of an employee," 235 strongly agreed, and 109 moderately agreed about the critical factor "freedom to experiment given in workplace contributes to the innovative skills of an employee."

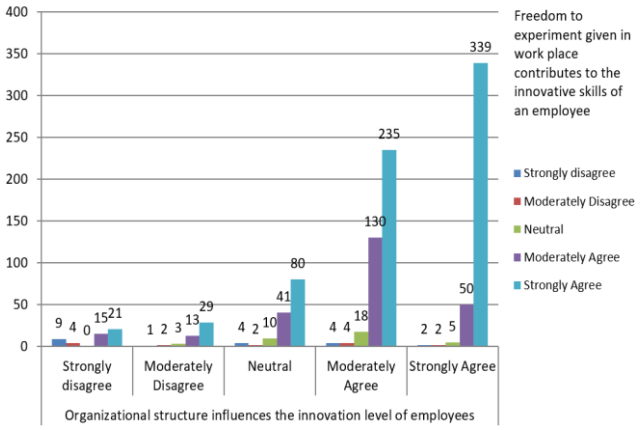

Figure 5: Chart comparing "organizational structure influences the innovation level of employees" and "freedom to experiment in workplace contributes to the innovation skills of an employee"

A comparison between the key factors, "opportunity influences innovation" and "intense competition influences innovation," is graphically represented in Figure 6. As shown, among the respondents who strongly agreed that "opportunity influences innovation," 247 strongly agreed, 141 moderately agreed, and 45 were neutral about the key factor "intense competition influences innovation." Similarly, among the respondents who moderately agreed that "opportunity influences innovation," 94 strongly agreed, 218 moderately agreed, and 88 were neutral about the key factor "intense competition influences innovation."

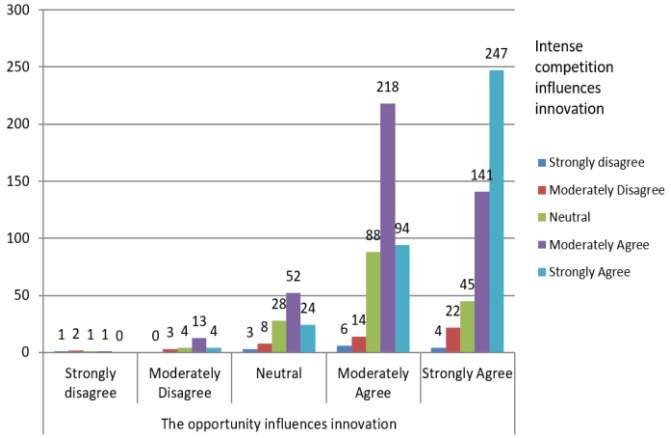

Figure 6: Chart comparing "opportunity influences innovation" and "intense competition influences innovation"

CONCLUSION AND FUTURE SCOPE OF THE STUDY

Conclusion

Innovation is essential and responsible for driving the economy. It is also necessary for an organization to stay ahead of the competition and survive in the business. Many instances exist in which conglomerates that did not innovate have not survived or could not hold on to their positions in the market in terms of revenue, products, market share, etc.

Despite much interest in innovation, researchers needed help understanding the mechanism by which innovation takes place. They also needed to learn the paradigm of innovation. An in-depth literature review identified two major factors, tangible and intangible, responsible for innovation. Thus, it was clear that not only tangible factors like R & D facilities and other infrastructure are solely responsible for innovation, but many other factors also contribute to it. These factors are not simple but complex. Tangible and intangible factors pertain to people working in the organization concerning the organization's management and the external environment.

It is essential to know which of the various factors significantly influences innovation. Thus, the study identified 25 factors. An instrument in the form of a survey with all 25 factors as items was sent to IT professionals working in the cross-section of the IT industry, and their opinion was sought.

By applying a large sample z-test for proportions and testing the hypothesis for each of the 25 factors, 13 factors were shortlisted to influence innovation significantly. The study tested the hypotheses for all 25 factors, and it rejected the null hypotheses of 13 factors, and they were identified as having a significant influence on innovation. Thus, applying the statistical processes to the responses received from the IT professionals, their perception of each factor was assessed, and the result was obtained. This clearly indicated the factors an organization must look upon and give importance to. The 13 factors identified were dependent on each other. Correlation analysis was used to understand the interdependency among the innovation factors. Accordingly, one factor was compared with all the factors, and the results were tabulated.

Future Scope of the Study

The study noted that the innovation capability of different organizations varies as specific processes are followed to increase or retain it. Thus, within the purview of each of the 13 factors, a few particular practices were listed for an organization to become innovative.

The innovation index tool is a continuation of this research, which has 13 factors as main components and 36 practices and attributes as sub-components. These practices and attributes are the main essence of the innovation index, which is created to indicate an organization's innovation capability.

A mathematical model is devised for the innovation index, which will be used as a measurement tool to assess an IT organization's innovation potential.

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