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Identification and prioritization of innovation barriers in industrial organizations

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Abstract

Innovation is a powerful promoter force to achieve a better business performance in competitive and changing nowadays markets as well as the heart of economic development. Technologic change is one of the main competition bases; and its main role is changing the industrial structure as it can create new industries. This study tries to investigate factors influencing innovation process by reviewing innovation and technological innovation literature, and identifies obstacles of innovation growth, using these factors according to special conditions of Iran. Next, via field research in 21 active firms at the area of high voltage electricity equipment in the country, effectiveness of each factor in slowing trend of industrial technological innovation is determined and their related weights are calculated. In the next phase, final preference of each factor is specified. At the end, to present suitable recommendations, action priority of each factor is evaluated and suggestions are made.

Keywords: Innovation; Technological innovation; Technology management; Technology transfer.

1. Introduction

Innovation is a powerful promoter force to achieve a better business performance in competitive and changing nowadays market as well as heart of economic development *(Jahangard, 2004)*. The only advantage of competition in today world is innovation. New competing world is formed based on knowledge-based economy and competition has changed between companies. . Now, in addition to higher efficiency, lower prices, and better quality, it is critical to make diversity in products and services, and it should be confirmed that there is a direct relation between innovation in companies and their presence in financial markets.

Thus, according to great role of innovations in economic growth and even economic development, from 1970s on, some changes occurred in world economy's structure, and industrial companies tended to development of production processes. Manufacturers focused their strategies on customers. Finally, customer found a high state. All these changes increased country need to recognition of innovation process at different levels of firm, regional, and national.

This work utilizes questionnaire method in field research to determine inhibiting factors of innovation growth and development in manufacturing industries of the country. Then, priority of each factor is specified in three stages of (1) priority of shortcoming, (2) weight priority and (3) final priority and (4) action priority, and the best solution is suggested to achieve the most resultful action.

This paper is organized as follows. Previous research on Innovation process, factors and barriers is summarized in Section 2. In Section 3, we present our hypotheses. We then explain research methodology in Section 4. Section 5 demonstrates the results of the research. Section 6 provides concluding remarks and offers suggestions for future research.

2. Literature Review

By a simple definition, technology is tools, methods, and operations used to convert consumable items to product (input to output) (Daft, 1978). All organizations use technology to get their goals. Futurist firms take technology as an accelerator, but not a creator in their movement. They never take technology as a primary tool for creating evolution. However, it is surprising that they are the best in using top technologies; but results of researches show that technology is not a primary reason for rising and falling of an organization spontaneously (Iranizad, 2009).

Marquis (1969) defined innovation as introducing "a unit of technology change", and his purpose of technology change is a new product, service, and/or process. Drucker (1985) presented innovation as special tool of entrepreneurs that help use a change as an opportunity for commerce and service delivery, and considered innovation as a teachable and executable ability in organizations. The valuable points in Drucker's definition are teaching ability of innovation for intra-organizations entrepreneurs to transfer threads to profitable opportunities. Technological innovations are usually divided into product technological innovation and process technological innovation (Garsia and Calantone, 2002). Each innovation is supposed to be applied when it reaches the market (product innovation), or it is used in a manufacturing process (process innovation). However, it should be noticed that the product or process must be new or fully developed technologically for a company (or other levels such as region and country). Developing technologic innovation is often explained as a linear process of fundamental researches to practical research, development, commercialization, propagation, and results of innovation. A linear model of innovation development process is not capable to take into account external environment factors, i.e. demand, and market regulatory

changes, influencing technologic innovation process. Technology transfer pass through these stages from research and development to commercialization, and then, with focus on intermediates between researches and commercialization (Tour, 2011).

2.1. *Evolution patterns of technologic innovation process*

Up to 1980s, presented models for innovation process were based on simple linear process, starting with fundamental researches, leads to idea creation, and finally, producing new product or process. Nevertheless, more detailed investigations and wider researches of innovation process behaviors at different conditions, some complications were observed, which could not be summarized in a simple linear process. Therefore, nonlinear processes were evaluated and different researchers tried to explore innovation processes, which will be mentioned below (Dodgson, 1997). Finally, the credible and important model of Kline-Rosenberg value chain (Kline and Rosenberg, 1986) is selected as evolutionary model. This model summarizes innovation process in five stages, shown in figure 1.

1. Identifying the potential and need the work market
2. Inventing or creating the analytic plan to produce a new product
3. Designing the details, testing the designs and redesign
4. Manufacturing
5. Distributing and marketing

So the major activities affecting the innovation process according to this model are:

- Research and development
- Equipping the industries
- Production start up
- Marketing for new products
- Achieve the physical and nonphysical technologies
- Designing

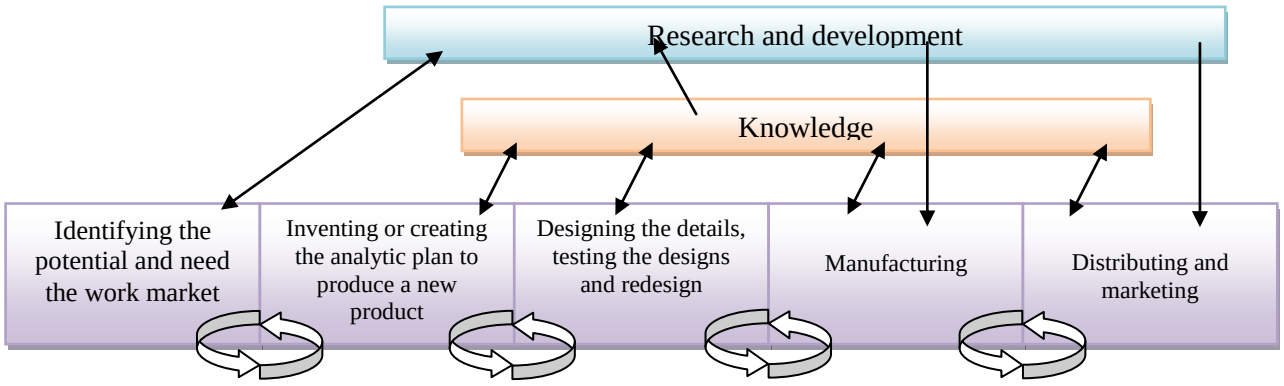

FIGURE 1: KLINE-ROSENBERG CHAIN VALUE MODEL

Chesbrough (2010) investigated opportunities and barriers in business model innovation. Choosing the business model as their unit of analysis, they identify novelty, lock-in complementarities and efficiency as key aspects of business model innovation. However, these may often conflict with the more traditional configurations of firm assets, whose managers are likely to resist experiments that might threaten their ongoing value to the company. A vice president of a field sales organization, for example, might take strong exception to experiments with online sales of the same products, whether they are successful or not. Perez Luno et al (2011) Build a theoretical model based on the Entrepreneurial Orientation literature and utilize a unique sample of innovating firms.

2.2. Factors affecting on formation of innovation processes

In summary, according to mentioned investigations, effective factors and parameters on firms' innovation can be separated into two main groups (Jahangard, 2004):

a) Interior factors of firms
b) Exterior factors of firms

Interior factors are called innovation engine, including sophisticated system of interior factors influencing on innovation process. Internal factors is called innovation motor that while the literature regarding product innovation has proliferated, it frequently contains elusive and ambiguous concepts of product innovativeness and new product performance, and clear insights into the relationship between them are lacking. Product innovativeness is derived from product innovation. Based upon the definition provided by Jordan and Segelod (2006), product innovativeness indicates the degree of newness in 'the development of new products, changes in design of established products, or use of new materials or components in the manufacture of established products. Griffin (2002) and Langerak and Hultink (2006) also refer to product innovativeness as the degree of newness in new products. Product innovation performance is abroad construct, and can refer to different aspects of product innovation. These differences may arise from the use of different measures for product innovation. The measures adopted in previous studies include product innovativeness and innovative product sales. Szymanski et al. (2007) meta-analytic review suggests that there is a positive association between product innovativeness and innovation performance. Much literature has explored the relationship between external technology acquisition and product innovation performance. A thorough review of these studies suggests that the link of the two constructs has been investigated from several angles. Some studies consider external technology acquisition as a whole, exploring its effects on the market performance of new products (Jones et al., 2001; Montoya et al., 2007). On the other hand, some studies link innovation performance with different acquisition strategies, mergers and acquisitions (Ahuja and Katila, 2001), technology alliances (Schoenmakers and Duysters, 2006), collaborative networks (Nieto and Santamar, 2007), and technology licensing (Tsai and Wang, 2007). Collectively, these studies are conducted at the firm level and contribute to the understanding of the relationship between external technology acquisition and product innovation performance.

However, existing research has produced inconsistent findings. Some studies find that these relationships are negative or insignificant (e.g., Jones et al., 2001; Tsai and Wang, 2007), while others find that they are positive (e.g., Ahuja and Katila, 2001; Nieto and Santamarı, 2007). These inconsistencies suggest that several moderating variables maybe at play. Previous studies measure configurational context using variables of age and size (Baker and Cullen, 1993). Although many studies explore the relationship between firm age and size and innovation, they focus on innovation adoption or firm productivity (the growth of value added) or patent counts. In other words, relatively little research explores the relationship between firm size and age and product innovativeness. Also, prior literature examines the effect of firm size and age, and not the actual moderating role of these variables. In contrast, this study explores the moderating effects of firm size and age, rather than their direct influences on product innovation.

In other research Howell et al. (2005) measured the psychometric properties of the product innovation champion behavior. Results from principal components and confirmatory factor analyses yielded a 14-item champion behavior measure composed of three factors: expressing enthusiasm and confidence about the success of the innovation, persisting under adversity, and getting the right people involved. This measure showed acceptable reliability as well as convergent and discriminate validity.

Preliminary evidence of criterion-related validity indicated that the champion behavior measure was also positively related to project performance. Together these analyses provided support for the construct validity of the champion behavior measure. Samad (2012) determine the influence of innovation and transformational leadership on organizational performance in Malaysian logistics companies. Results show product or service in innovation emerged as the most important factors that influence performance of organization.

2.2.1. Interior factors influencing on innovation process of firms

Afuah (1998) mentions interior factors affecting on innovation organizations as four below ones:

- Innovation strategy
- Organizational structure
- Processes and systems
- People

Innovation strategy leads companies to carry out a set of actions with specified schedules and the way that sources are allocated, while a firm structure says that who is in charge with which responsibility. In a perfect structure, besides specialization in each unit, it must be attended sufficiently that how information and knowledge are exchanged between different units as well as units cooperation, to reach the interested product or service. Management should be able to design and implement suitable payment systems based on people performance and activities. Thus, systems should be formed in a way that correct information is provided for management of teams to make decisions in the shortest time. With these systems, whether personnel and people are provided effectively with information available from the systems to make decisions.

Many researchers have discussed effect of company size on technologic innovation. Some believe big-size companies are more successful in gaining technologic innovations due to extended access to intrinsic research and development. Unlike above, some think that small and medium enterprises are more successful in attaining technologic innovation -especially emerging technologies- because of higher flexibility (Stock et al., 2002). In addition to company's size, type of industry, which company involves in, is effective in innovation process. Studies in R&D member countries have revealed that big-size companies have a relatively high contribution in developed technology industries. This contribution decreases with approaching to low technology sections, and contribution of small and medium enterprises increases instead. Moreover, these studies showed that contribution of innovative firms changes from 43% of low technology industries to 71% in developed technology industries. It is noteworthy that contribution of innovative firms in low technology industries is not negligible in surveyed countries.

Hung and Tang (2008) through an empirical analysis identified the influential factors and their impact using a multi-factorial analysis of the choice of technology acquisition mode. They demonstrated that the technological capability including technological level, technological innovation and research and development (R&D) activities of a firm are the most significant factor in influencing the determination of the mode of technology acquisition. Garcia-Morales et al., (2012) based on a sample of 168 Spanish firms reveal that (1) transformational leadership influences organizational performance positively through organizational learning and innovation; (2) organizational learning influences organizational performance positively, both directly and indirectly through organizational innovation; (3) organizational innovation influences organizational performance positively.

2.2.2. Exterior factors influencing innovation process of companies

Generally, in addition to interior factors of companies stated in previous section, external environment of companies also has a great effect on formation of innovation process. Overall, they can be grouped in 4 categories:

- General frameworks dominating the society
- Engineering, sciences, and technology basis of society
- Availability of communicational networks

Big companies have material and information advantages due to ability of supporting the R&D, while SMEs have behavioral advantages because they have more flexibility resulting to higher potential for adapting with market changes.

Many industrial firms traditionally focused on internal research and development in their innovation activities (Gronlund et al., 2010). In contrast, some firms have actively collaborated with external partners in their innovation processes for many decades (Mowery, 2009). In recent years, however, the trend towards innovation collaborations across organizational boundaries has intensified (Chesbrough, 2006; Hagedoorn, 2002). This trend seems to further continue at present, and many firms now acquire a major portion of their technologies from external sources (Bierly et al., 2009). For instance, many pharmaceutical firms spend more than 25 percent of their R&D budgets on services provided by other organizations, and this figure will likely increase to 40 percent (Lichtenthaler, 2008). In addition, many firms now actively transfer some of their own technology to external partners. For example, Dow Chemical, IBM, and several other firms each achieve over 100 million of dollars in annual licensing revenues (Chesbrough, 2006).

Ahuja and Katila (2001) investigate external technology acquisition effects on M&A strategy and examine innovation performance (patent) effects of acquiring firms in the global chemicals industry. The evidence from 72 leading firms shows that the absolute size of the acquired knowledge base enhances innovation performance.

2.3. Innovation barriers

In early 1992, 16Organization for Economic Cooperation Development (OECD) member countries attempted to integrate previous studies in the field of innovation. Their main purpose was to know effective parameters on innovation in all level so they can compare innovation situation of countries. Finally, they documented an instruction called OSLO, which presented effective parameters on technologic innovation process at firm level based on surveys in different European countries.

In a research, Hadjimanolis (1999) study the barriers to innovation for SMEs in Cyprus asa small less developed country. He classifies the barriers in two categories, internal and external barriers then determines the priority of each of the sub factors. So, shortage of skilled labour in external barriers and lack of time in internal barriers are the most important sub factors in all of the barriers. In other side, Zell (2001) identify five factors as innovation barriers: 1-innovation itself, 2-Transfer, 3-Implementation, and 4-Human dynamics. He investigates win principles and common barriers to the diffusion of innovation. These win principles are: pull mechanism, networking, peer consulting, safe environment and action research.

In addition, Ren (2009) investigated the barriers and drivers for process innovation in the petrochemical industry. He presented some of the main drivers and barriers to activities aimed at improving existing processes and developing new processes. He found that the most important drivers for improving existing processes are cost savings, tight supply of feedstock and the personal

commitment of individuals. In other side, shortage of staff and time, a lack of prioritization and relying on proven configurations and operation control are general barriers to improving any kind of existing process.

Also, Ren (2009) defined the innovation drivers for developing new processes are: 1-The possible economic gain from the conversion of low-cost feedstock to high-value basic products, 2-Fierce competition between process licensors and engineering firms as well as between producers, 3-Tthe need to broaden the application of existing knowledge. In other vice, the barriers developing new processes are:1-Recurring unfavorable economic conditions, 2-Conventional tools for modeling processes and making decisions are seen by producers and engineering firms as insufficient to deal with the high uncertainties inherent in the long-term development of new processes, 3-Concern for job security.

Blind (2012) investigate the impact of different specific regulations on innovation in 21 OECD countries using panel data for the period between 1998 and 2004. He found that modifications in regulatory and legal framework conditions have a significant influence on the dynamics of innovations OECD countries. Este et al. (2012) determine importance of distinguishing between two different effects of the obstacles that firms face in undertaking innovation activity. The first effect is related to increasing awareness of the difficulties involved in innovating, or the "disclosing" and "learning" content of direct experience. The second effect is related to the perception of the impediments to innovation by firms that otherwise would be keen to engage in this activity.

The study, done by Iranian committee of scientific researches, explains barriers of technologic innovation in several aspects, and divides them into seven categories:

- Barriers related to management, policy making, and research system
- Barriers related to research culture
- Barriers related to researchers
- Barriers related to circumstances of research and scientific standards
- Barriers related to research rules and regulations
- Barriers related to research budget and facilities
- Barriers related to end-user

In this research, identified factors are about innovation in all of society, and most of factors are in this view that government is the only responsible in the country. However, in industry section, organizational and cost structure, active human source, and available knowledge are very important too.

3. Problem statement and research necessity

What attracts innovators and pioneers of technology is high profit taking and resulted advantages of being pre-eminent. If being pre-eminent in technology raises efficiency of organization rather than competitors, it will cause superiority and cost advantage. World Economic Forum and Boston Consulting Group carried out a research to seek for practical solutions to confront existing challenges in the way of sustainable development and growth, to identify and support key effective activities, and to develop and promote them in the world. In the research, they selected 16 top active companies in emerging markets as the best in using innovation for sustainability, according to three criteria of sustainability, innovation, and performance. This project deliberately ignores government, environmental organizations, multi-national companies, and notes the companies in developing

countries, which are faced to a wide range of limitations in their activities and business such as population increase, source limitation, insufficient infrastructures, poor environmental control systems, undeveloped performances of government, etc. One of its most important results is that regulations cannot determine sustainable development approaches lonely. In the long term, governments and firms cannot carry out effective actions to promote sustainability objectives independently. The solution should be sought in innovative approaches. Innovation, optimum using of economic opportunities, attempt and commitment of business leaders to social and environmental improvement, and cooperation of policy makers are keys to obtain sustainability objectives.

Based on World Economy Forum ranking for year 2011-2012, according to compatibility criterion, Iran is 62th country among 142 countries in the world. In ranking by the criterion of "effective factors in innovation and being developed", Iran has the 83th rank. Due to World ranking of Iran, investigating weakness reasons and innovation barriers in the country has great importance.

In this research we will answer to 3 main questions:

1- What factors prevent offering and performing innovation in the industrial companies of Iran?
2- How much effect does each factor have on preventing innovation process in industrial companies?
3- Witch action is the best action to achieve the most resultful action?

By exploring previous inbound and outbound studies in the field of identifying innovation barriers, and considering special conditions of the country, this research presents the most important barriers of innovation growth and dynamicity in the country in 6 categories of (i) cost factors, (ii) knowledge factors, (iii) market factors, (iv) governmental factors, (v) organization structure factors, (vi) human factors, and 63 sub-categories:

	Cost factors
VAR1	Excessive perceived risk of innovation
VAR2	Innovation cost is too high
VAR3	Lack of funds within the enterprise
VAR4	Lack of finance from public sources of funding outside the enterprise
VAR5	Lack of venture capital companies (governmental or private)
VAR6	Short-term economic, monetary and financial policies
VAR7	Pay-off period of innovation too long
VAR8	Insufficient research budget in organizations
	Knowledge factors
VAR9	Lack of testing institutions
VAR10	Lack of information on technology
VAR11	Limited access to research institutions
VAR12	Inaccessibility to exterior services (out of organization or country)
VAR13	Difficulty in finding co-operation partners for product or process development
VAR14	Difficulty in finding co-operation partners for marketing partnerships
VAR15	Lack of opportunities for cooperation with other firms and technological institutions
VAR16	Poor access of researchers to scientific sources in the country
VAR17	Lack of necessary material, equipment, tools, and information in the country

	Market factors
VAR18	Uncertain demand for innovative goods or services
VAR19	Rapid changes of technology
VAR20	Potential market dominated by established enterprises
VAR21	Lack of information on markets
VAR22	Lack of customer responsiveness to new products and processes
VAR23	No need because of lack of demand for innovations
VAR24	Economic interdicts against the country
	Governmental factors
VAR25	Lack of infrastructure
VAR26	Legislation, regulations, standards, taxation
VAR27	Foreign trade policy (import tariffs)
VAR28	Government policy to assist small firms
VAR29	Policy on public contracts and government purchasing
VAR30	Government policies on competition
VAR31	Plurality of research custodians in the country
VAR32	Lack of proper research and science management pattern in research and scientific centers
VAR33	Fraction between research centers and executive entities
VAR34	unreality of research priorities and lack of a systematic approach in analyzing and clarifying the needs
VAR35	Lack of pursuing custodian organization for applying results of researches
VAR36	Lack of proper system for cooperation between industries and academies
VAR37	Lack of proper budget allocation for research and development section in the country
VAR38	Inappropriate consumption of research budget and its wrong distribution in the country
VAR39	Existing bureaucracy in providing authorized budget of research plans
VAR40	Lack of clarity of regulations and rules of patents and copyright for innovations
VAR41	Multi-regulatory, instability, and permanent changes in governing rules of research without applying opinions of superior researchers
	Structural factors of organization
VAR42	Innovation potential (R&D, design, etc.) insufficient
VAR43	Lack of support for changes in policies and applications
VAR44	Wages policy
VAR45	Resisting the personnel towards change
VAR46	Resisting the managers towards change
VAR47	Lack of motivation (e.g. high profitability with current product mix)
VAR48	Lack of a clear technology strategy
VAR49	Lack of time (e.g. one man responsible for many tasks)
VAR50	Lack of technological experience necessary for development of specific innovations
VAR51	Insufficient communications between organization's units
VAR52	Lack of group work culture in organization
VAR53	Lack of organizational willpower and pride in the context of research-based production and innovation
VAR54	Inattention and distrust of managers to researches findings
VAR55	Lack of proper structure for top and stuff management in research system

	of the country
VAR56	Poor scientific managing in attracting and directing participations of private and government sections
VAR57	Indeterminacy of research results and disusing them
	Human factors
VAR58	Lack of qualified personnel within the enterprise
VAR59	Lack of qualified personnel in the labour market
VAR60	Inadequate technical training of employees
VAR61	Lack of job security and mental serenity about present and future of life for researchers
VAR62	Low ratio of researchers to total population in the country
VAR63	Lack of appropriate structure of education system to raise capable researchers

Above 63 factors are considered assumptions of research as barriers in the way of innovation creation and presentation.

4. Research methodology

In this section we describe the research methodology. Active manufacturing firms in the high voltage electricity of Iran are selected as population in this research. From 2000 manufacturing, servicing, contracting, consulting, and repairing firms, 370 firms are members of electricity industry syndicate. From these firms, 183 are working in producing goods related to high voltage electricity.

According to research type, questionnaire that requires a higher perception of inhibiting factors of mentioned innovation growth, and for prohibiting high variance and standard deviation of answers, employees with bachelor degree or higher degrees are selected as statistic population. Thus, size of population is 4477 people.

Cochran method is used to determine sample size assuming normal distribution of variables, which results shows sample size is equal to 358.In present research; a questionnaire is designed based on objectives and assumptions of research. Totally, 360 questionnaires were distributed in 21 firms with interested activity, which 285 completed questionnaires were collected.

In this research, Fake test is employed to determine validity of questionnaire. Hence, we utilized expert opinions of professors and technical experts in this research. Then, questions corresponding to each assumption are designed according to opinions of supervisor and consulting professors, and after their approving; it is distributed among members of population.

In this study, we use Cronbach's Alpha method to measure reliability of questionnaire. SPSS software evaluated Cronbach's Alpha coefficient, which is equal to 0.975. Therefore, it can be said that designed questionnaire for the research has a high reliability. Ordinal scale is employed to convert qualitative variables to quantitative ones in this work.

This research uses two methods of descriptive and inductive to analyze obtained data. In descriptive level, we describe population attributes using statistical parameters such as frequency, percentage, average, median, mode, variance, standard deviation, and variation coefficient. Statistical hypothesis test is employed for two motives. The first motive is testing purposed others' claim, and the second is

confirming purposed ideas of a researcher in scientific study. For correlation test, we use Kendall's tau-b to obtain valid answers.

5. Result

Results are analyzed in four stages in the research.

1) Examining research's assumption
2) Investigating situation of each factor as being a barrier for innovation in the industry
3) Determining weights of factors
4) Determining final weights of factors
5) Specifying action preference to eliminate barriers

5.1. Examining research's assumption

In the average test, first, average value, equal to real average of ordinal scale i.e. μo=5, is set. From equation (1) gives

$$\begin{cases} H_0: \mu \geq 5 \\ H_1: \mu < 5 \end{cases} \qquad (1)$$

Examining results of average test respect to average of 5, it is found that 62 of 63 factors have level of significance less than 0.01. It means that these 62 factors are inhibiting factors for creating and presenting innovation in high voltage electricity industry of the country more than average level with probability of 0.99. Insufficient potential for innovation (R&D, design, etc.) is the only factor prohibiting innovation growth in the country's industry at a medium level.

5.2. Investigating situation of each factor as being a barrier for innovation in the industry

In this stage, we calculate mean scores of factors as being barrios for innovation, and factors are sorted according to the factor has the maximum shortage in the industry. Results of this stage have been shown in table (1).

TABLE 1: SCORES AND PRIORITY BASED ON BEING A FACTOR AS A BARRIER

Variable No.	Score	priority	Variable No.	Score	priority	Variable No.	Score	priority
VAR61	7.85	1	VAR55	6.47	22	VAR58	6.09	43
VAR33	7.13	2	VAR60	6.45	23	VAR04	6.08	44
VAR36	7.11	3	VAR49	6.45	24	VAR45	6.07	45
VAR63	7.1	4	VAR57	6.42	25	VAR46	6.02	46
VAR12	6.94	5	VAR02	6.42	26	VAR43	6	47
VAR25	6.92	6	VAR30	6.41	27	VAR13	5.98	48
VAR37	6.92	7	VAR47	6.33	28	VAR14	5.98	49
VAR38	6.9	8	VAR31	6.33	29	VAR09	5.97	50
VAR44	6.89	9	VAR03	6.31	30	VAR01	5.96	51
VAR39	6.79	10	VAR40	6.24	31	VAR16	5.95	52

VAR08	6.78	11	VAR50	6.24	32	VAR21	5.91	53
VAR52	6.76	12	VAR29	6.24	33	VAR59	5.9	54
VAR35	6.74	13	VAR07	6.21	34	VAR53	5.85	55
VAR34	6.67	14	VAR54	6.17	35	VAR51	5.81	56
VAR62	6.65	15	VAR17	6.16	36	VAR15	5.77	57
VAR24	6.59	16	VAR11	6.15	37	VAR28	5.63	58
VAR18	6.59	17	VAR41	6.14	38	VAR20	5.62	59
VAR05	6.58	18	VAR48	6.12	39	VAR23	5.6	60
VAR56	6.52	19	VAR06	6.09	40	VAR22	5.52	61
VAR27	6.49	20	VAR26	6.09	41	VAR19	5.41	62
VAR32	6.49	21	VAR10	6.09	42	VAR42	5.2	63

5.3. Determining weights of factors

To determine importance of each factor in the whole process of innovation, there was a column in the questionnaire that participants determine importance weight of factors as a number in range of 1-20 based on their views. After collecting data, we normalized data using fuzzy normalization method by Microsoft Excel. We normalized data because maximum and minimum values, given in answers, were different. For example, maximum score was 10 from a participant view, 15 for another, and 20 for the other. Given scores cannot be aggregated without normalization according to this fact that maximum and minimum of weights is set 1-20 in this research.

Fuzzy normalization, which is a nonlinear method, is as follow:

$$r_{ij} = \frac{x_{ij} - x_i^{min}}{x_i^{max} - x_i^{min}} \qquad (2)$$

Where, Xij is given weight, Ximax is the maximum given weight by participant, and Ximin is the minimum given weight by participant.

Resulted scores are in the range of 0 to 1 for this method.

To attain considered weights and remove zeroes from resulted weights, we extend the interval from [0,1] to [1,20]. Now, we can apply mathematical operations on them. Thus, average method is employed to calculate final weight of each factor. Table (2) presents the scores and priority of the weight of factors.

TABLE 2: SCORES AND PRIORITY BASED ON WEIGHT OF FACTOR

Variable No.	Score	priority	Variable No.	Score	priority	Variable No.	Score	priority
VAR61	16.49	1	VAR12	13.18	22	VAR50	12.03	43
VAR08	15.14	2	VAR40	13.15	23	VAR05	12.02	44
VAR60	14.62	3	VAR44	13.1	24	VAR18	11.94	45
VAR10	14.6	4	VAR46	13.01	25	VAR51	11.86	46
VAR63	14.46	5	VAR27	12.98	26	VAR26	11.72	47
VAR25	14.31	6	VAR57	12.97	27	VAR28	11.6	48

VAR03	14.28	7	VAR17	12.93	28	VAR01	11.6	49
VAR38	14.05	8	VAR56	12.91	29	VAR42	11.57	50
VAR52	13.96	9	VAR55	12.89	30	VAR04	11.39	51
VAR58	13.89	10	VAR62	12.74	31	VAR15	11.39	52
VAR47	13.86	11	VAR21	12.66	32	VAR13	11.34	53
VAR34	13.83	12	VAR30	12.62	33	VAR29	11.34	54
VAR33	13.73	13	VAR02	12.59	34	VAR53	11.31	55
VAR37	13.64	14	VAR54	12.57	35	VAR43	11.25	56
VAR35	13.58	15	VAR41	12.52	36	VAR31	11.01	57
VAR07	13.58	16	VAR16	12.44	37	VAR49	10.79	58
VAR11	13.58	17	VAR14	12.39	38	VAR22	10.74	59
VAR36	13.53	18	VAR06	12.34	39	VAR19	10.58	60
VAR59	13.41	19	VAR24	12.23	40	VAR45	10.26	61
VAR39	13.29	20	VAR48	12.16	41	VAR23	9.79	62
VAR09	13.29	21	VAR32	12.07	42	VAR20	8.96	63

5.4. Determining final priority of factors

In sections 2 and 3, we prioritized factors according to the factor that industry has the maximum shortage of, and calculated weights of factors for innovation. In this phase, final priority of factors is evaluated according to previous results. To do this, we multiply score obtained in stage 2, which is score of factor as a barrier for innovation, in weight of the factor. Therefore, final priority of factors is achieved based on their Importance and shortage extent.

Score of final factors = Score of being a factor as a barrier×weights of factor (3)

Table (3) shows the results of equation (3) that arranged according to priority of final score of each factor.

TABLE 3: SCORES AND PRIORITY BASED ON FINAL PRIORITY OF FACTOR

Variable No.	Score	priority	Variable No.	Score	priority	Variable No.	Score	priority
VAR61	129.43	1	VAR27	84.28	22	VAR48	74.48	43
VAR63	102.62	2	VAR56	84.12	23	VAR14	74.04	44
VAR08	102.59	3	VAR11	83.51	24	VAR16	74	45
VAR25	99.09	4	VAR57	83.35	25	VAR26	71.42	46
VAR33	97.94	5	VAR55	83.32	26	VAR29	70.77	47
VAR38	96.96	6	VAR40	82.07	27	VAR31	69.64	48
VAR36	96.1	7	VAR30	80.87	28	VAR49	69.58	49
VAR37	94.42	8	VAR02	80.87	29	VAR04	69.29	50
VAR52	94.38	9	VAR24	80.64	30	VAR01	69.13	51
VAR60	94.33	10	VAR17	79.61	31	VAR51	68.89	52
VAR34	92.26	11	VAR09	79.3	32	VAR13	67.84	53

VAR35	91.53	12	VAR59	79.1	33	VAR43	67.44	54
VAR12	91.41	13	VAR05	79.07	34	VAR53	66.15	55
VAR39	90.23	14	VAR18	78.7	35	VAR15	65.75	56
VAR44	90.2	15	VAR46	78.3	36	VAR28	65.32	57
VAR03	90.12	16	VAR32	78.29	37	VAR45	62.31	58
VAR10	88.9	17	VAR54	77.6	38	VAR42	60.12	59
VAR47	87.75	18	VAR41	76.86	39	VAR22	59.26	60
VAR62	84.68	19	VAR06	75.22	40	VAR19	57.22	61
VAR58	84.56	20	VAR50	75.09	41	VAR23	54.82	62
VAR07	84.28	21	VAR21	74.83	42	VAR20	50.38	63

5.5. Specifying action preference to eliminate barriers

In sections 2 (literature review), we prioritized factors according to the factor that industry has the maximum shortage in that. Then, in stage3, we calculated weights of factors for innovation. In this phase, final priority of factors is evaluated according to previous results.

None of priorities, gained in stages 2 and 3, can specify which factor has higher priority. Thus, we achieve some information by integrating score of shortage extent and weight of factors, using them it is possible to estimate final weight of factors. It is done in stage 4 and priorities are determined.

According to resulted preferences, this question is put forward that whether it is true to take actions directly based on these orders and take steps to remove these barriers in the way of innovation growth and presentation in the country industries.

What should be considered here is that none of these factors is created spontaneously and can be removed solely. Each of them is linked to hundreds of factors. To eliminate them, the most fundamental one should be considered and corrected, so its resulting barriers will be eliminated.

This research just considers 63 factors among all related factors according to its objective, which is identifying factors related to slowing growth and presentation trend of innovation. Now, the question is how we can determine the best option to achieve the most effective action.

It should be noticed that the most effective action is not necessarily solution of the most important factor. The most effective option to take action is the factor, which has the most influence on the most important factors. In other words, we remove the issue that removes or improves more problems.

To find these factors, correlation test is employed. Based on research methodology section, we use Kendall's tau-b correlation for determining correlation of factors. According to this fact that all factors are related more or less, level of significance is set 0.01 to determine correlation of factors.

First, correlation test of Kendall's tau-b is applied on each pair. Then, factors' pairs with correlation probability more than 0.99 are investigated and lower probabilities are ignored, to obtain more accurate answers.

Next, we multiply correlation value of factors (with significance level of 0.01) correlated to a given factor in final priority value of each factor (calculated in section 4), and aggregation of all values is considered as action priority. Thus, action priority of all factors is achieved.

Table (4) shows the action priority classification.

TABLE 4: SCORES AND PRIORITY BASED ON ACTION PREFRENCE

Variable No.	Score	priority	Variable No.	Score	priority	Variable No.	Score	priority
VAR17	1632.84	1	VAR10	1262.76	22	VAR52	1040.88	43
VAR41	1592.35	2	VAR48	1258.17	23	VAR12	1002.09	44
VAR34	1585.04	3	VAR28	1258.12	24	VAR54	995.62	45
VAR43	1584.34	4	VAR39	1213.42	25	VAR25	975.63	46
VAR32	1545.07	5	VAR59	1201.91	26	VAR61	937.00	47
VAR57	1525.20	6	VAR08	1189.13	27	VAR44	926.12	48
VAR55	1515.29	7	VAR22	1156.82	28	VAR02	925.24	49
VAR09	1487.73	8	VAR63	1150.02	29	VAR62	919.84	50
VAR11	1440.24	9	VAR27	1146.37	30	VAR05	841.50	51
VAR56	1438.05	10	VAR51	1134.63	31	VAR19	837.29	52
VAR16	1437.02	11	VAR14	1112.72	32	VAR21	796.91	53
VAR33	1387.85	12	VAR38	1103.94	33	VAR49	769.38	54
VAR31	1385.47	13	VAR36	1101.83	34	VAR03	764.97	55
VAR15	1384.49	14	VAR58	1094.83	35	VAR06	751.63	56
VAR40	1347.16	15	VAR53	1089.36	36	VAR04	704.29	57
VAR30	1340.24	16	VAR37	1080.51	37	VAR20	573.68	58
VAR35	1334.64	17	VAR24	1077.32	38	VAR07	536.90	59
VAR60	1327.22	18	VAR29	1065.43	39	VAR23	513.26	60
VAR45	1317.05	19	VAR50	1059.12	40	VAR01	507.15	61
VAR13	1275.22	20	VAR47	1051.33	41	VAR18	491.47	62
VAR26	1267.46	21	VAR46	1043.85	42	VAR42	395.79	63

6. Summary, conclusions and suggestions

6.1. Summary of research

Technology change and innovation are among emphasized topics in Iran. Nevertheless, there is a vacancy of a comprehensive research about factors prohibiting growth and dynamism of innovation in country industries. This study tries to investigate previous works in determining factors influencing innovation process by reviewing innovation and technological innovation literature, and identifies obstacles of innovation growth of the country using these factors according to special conditions of Iran. Next, via field research in 21 active firms at the area of high voltage electricity equipment in the country, effectiveness of each factor in slowing trend of industrial technologic innovation is determined and their related weights are calculated. In the next phase, final preference of each factor is specified. This work utilizes questionnaire method in field research to determine inhibiting factors of innovation growth and development in manufacturing industries of the country. Then, priority of each factor is specified in four stages of (1) priority of shortcoming, (2) weight priority, (3) final priority and (4) priority of action preference.

6.2. Conclusions

In this section, the conclusions are presented. The following conclusions can be concluded from the results:

Job security and mental serenity regarding to payment policies are the most concentration and motivation disturbing factors between researchers, and is the most important inhibiting factor in innovation of industries. This factor not only has the most lack, but also has the most weight. It shows that concentration and mental peace of researchers have a great importance for carrying out studies and technologic researches. But, it should be considered that this factor is affected by many factors, which identifying them is very important. Industry does not acknowledge market factors and cost barriers as powerful barriers for innovation. Industry does not believe that there is no enough potential for innovation (R&D, design, etc.). It means that industry sees no shortage within itself versus potential for innovation. Lack of suitable education structure for rising up capable researchers is selected as second effective factor in reducing innovation growth in industrial or non-industrial organizations. This factor along with lack of personnel training factor are among the factors that demonstrate role of human resource in innovation process of country industries. High priority of government factors show that industry expects that government facilitates innovation growth conditions. The most important factors are documenting proper research policies, creating required infrastructures, and facilitating cooperation between industry and academies. Organizational structure, government factors, and knowledge factors are known as cause, and cost factors, market factors, and human factors are detected as effect.

All of four factors of organizational structure are about organization management. It means that attitude shift of organization management from traditional and condition-stabilizing methods and systems to modern and evolutionary methods facilitate flow of ideas and innovative methods in the organization. All three factors of knowledge factors show lack of research tool and equipment and not knowledge potential of personnel. These tools include knowledge generating equipment, test equipment, and special research centers. All three factors of government factors represent lack of clear research policy and explicit research vision. Lack of proper policies is resulted due to lack of independent policy making research entities. According to this fact that insufficient potential for innovation (R&D, design, etc.) has the lowest rank of action, it can be deduced that industry activists has enough self-confidence about creating technologic innovation. Thus, if required infrastructures are provided, innovation growth will start immediately.

6.3. Suggestions for future research

- Specifying the influence of each factor of its correlated factors and selecting the most proper action to eliminate the factor with employing the artificial intelligence tools.
- Identifying and prioritizing of activities to eliminate the barriers of innovation in industries.
- Conducting similar research in other industries i.e. petrochemical, food, pharmaceutical industry and collect all of the results to achieve the clear results in identify innovation barriers in Iran’s industry.

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