

Endeavoring Innovation via Research and Development Management: A Case of Iranian Industrial Sector

Reihaneh Montazeri Shatouri, Rosmini Omar, Wan Khairuzzaman Wan Ismail

Abstract—This study aims at investigating factors in research and development (R&D) growth and exploring the role of R&D management in enhancing social innovation and productivity improvement in Iran's industrial sector. It basically explores the common types of R&D activities and the industries which benefited the most from active R&D units in Iran. The researchers generated qualitative analyses obtained from primary and secondary data.

The primary data have been retrieved through interviews with five key players (Managing Director, Internal Manager, General Manager, Executive Manager, and Project Manager) in the industrial sector. The secondary data acquired from an investigation on Mazandaran, a province of northern Iran. The findings highlight Iran's focuses of R & D on cost reduction and upgrading productivity. Industries that have benefited the most from active R&D units are metallic, machinery and equipment design, and automotive.

We rank order the primary effects of R&D on productivity improvement as follows, industry improvement, economic growth, using professional human resources, generating productivity and creativity culture, creating a competitive and innovative environment, and increasing people's knowledge.

Generally, low budget dedication and insufficient supply of highly skilled scientists and engineers are two important obstacles for R&D in Iran. Whereas, R&D has resulted in improvement in Iranian society, transfer of contemporary knowledge into the international market is still lacking.

Keywords—Productivity, R&D, Transfer of Knowledge

I. INTRODUCTION

A Plethora of studies has captured issues of Research and Development (R&D) in various developed nations. Earlier literature depicts R&D as an engine for modernization and strategic trajectory towards growth. R&D enriches theories and practices of globalization, regionalization of technical and scientific expertise as well as market-led innovation [1].

Technological change and innovation driven by R&D have been one of the major sources of productivity growth over decades [2]. With the accelerating process of globalization and international competition, many corporations re-establish their strategies to allocate multiple resources for R&D development [3]. Nonetheless, numerous issues of R&D in some societies are still left unexplored.

Within the boundary of this paper, we define R&D as the process of investigative activities that is chosen to conduct and develop systems, products and services [4].

Reihaneh Montazeri Shatouri is with Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, 50300 Kuala Lumpur (phone: +6014-7268945; e-mail: montazeri.reihaneh@gmail.com).

Rosmini Omar is with International Business School, Universiti Teknologi Malaysia, 50300 Kuala Lumpur (phone: +603-26953318; e-mail: rosmini.omar@minotstateu.edu).

Wan Khairuzzaman Wan Ismail is with International Business School, Universiti Teknologi Malaysia, 50300 Kuala Lumpur (phone: +603-26948969; e-mail: mwkhair@ibs.utm.my).

It involves all steps in the system, service, and product development process from initial conceptualization to create a fully practical product that can be introduced to the market. The process of R&D would be exploring market demands and identifying innovative techniques to support them. The most common types of R&D activities include basic research, applied research, new product development, product adaptation and extension, product support engineering, and process engineering that the first two of which are categorized as "research" and the last four as "development" [5]. In the manufacturing sector for instance, an internal R&D department normally consists of professional experts who investigate in creating new products and technological improvements for the current products [6]. This department as a central innovative unit of the firms plays an important role in covering the market demands with an edge over other competitors.

The positive effects of R&D activities on productivity improvement cannot be ignored. Yet, the main problem in the way of R&D is that not only organizations do not invest in this precious unit, but also most of them look at it as a cost. Statistics from Investopedia website reveals that on average, companies usually spend under 5 percent of their revenue on R&D; however, pharmaceutical, software and semiconductor companies tend to spend quite a bit more in the world [7]. Experts believe that 2 percent of a firm's revenue could be sufficient in a moderate market, but to survive in the rapidly changing market, companies are expected to spend at least 15 percent in R&D [8]. Although, R&D has improved productivity in many societies, it is still facing challenges and problems, especially in developing countries. In spite of the fact that R&D initiates strengths and opportunities for organizations, investments towards R&D remains frugal in some societies. Whereas, R&D department creates innovative methods and techniques in the industrial sector, which resulted in the success of business, societies should consider it as a crucial investment in the firms.

This paper intends to bridge gaps in understanding R&D as bullets for growth and modernization by canvassing a case within the Iranian industrial sector. In an earlier empirical work [9] that studied Iranian's R&D management in productivity improvement, it is proven that the nation perform R&D despite suffering from lack of budget and specialist human resources in the R&D sector. According to the statistics, only around 2 percent of Iranian companies are benefited from active R&D units and the majority spend less than 1 percent of their revenue in R&D [9] while, industrial companies in developed countries spend around 30 percent of their revenue to research and development [14].

This study aims at investigating the effective factors in R&D growth and exploring the role of R&D management in enhancing social innovation and productivity improvement in Iranian industrial sector.

The next section will explore the relevant literature followed by the role of R&D strategies in profitability and productivity, common types of R&D activities in Iran industrial sector, and the industries benefit the most from active R&D units in Iran.

II. LITERATURE REVIEW

A. *The History of R&D*

R&D includes the processes that new products are brought into being through technological innovation. It refers to creative works taken on a systematic base in order to increase the knowledge stock, including knowledge of man, culture, and society.

Studies [14] that estimate the contribution made to economic growth by factors of production such as labour and capital have discovered that R&D spending has made a small, stable contribution to economic growth in the United States in the post-World War II. Numerous studies [14] have concentrated on the social return to R&D, which is defined as the total return to innovation containing the return earned by the original innovator, and any profit that other firms that are not involved in the R&D effort might gain. Therefore, non-innovative companies may benefit from the knowledge encompassing the original innovation. Results from econometric studies strongly indicate that R&D spending has a positive effect on productivity with a rate of return, which probably exceeds that on conventional investments. Previous studies have shown that the direct link between R&D and productivity is probably the correct one. It is absolutely expressed that R&D has a positive effect on productivity with a rate of return, at least equal to the return on other types of investments [14].

R&D has passed three generations in its historical evolution and growth. First of all, it was included in only laboratories and among scientists. Generally at this phase, researches were done individually which led to inventions and finally huge developments. In the second phase, besides laboratories, R&D units were established in factories. During this period, companies were faced to limited demands and close competition. Thus, R&D was creatively improved especially in the industrial sector. In the third generation, the performance of R&D units was revolutionized. During this era, R&D was used in industrial and governmental projects such as technology, politic, security, and cultural community issues. Moreover, decision-making was extended by managers to allow employees to participate in organizational decision-making. Therefore, industrial R&D investment coming together with employees' involvement in decision-making benefited everyone and solved the main companies' problems such as high producing costs and low products' quality.

R&D significantly affected technology, competitors, and market demands that all have been influenced the industry. Today, many countries invest in R&D to improve their current performance and consequently their efficiency. United States, Europe, Japan, and China are the major R&D investors in the world. They financially support companies and institutions to establish R&D unit to improve productivity in their societies.

In comparison, industrial sector is the major part, which benefit from active R&D departments in Iran [10].

B. *The Role of R&D Strategies in Profitability and Productivity*

R&D has a special economic significance besides its conventional alliance with scientific and technological development. R&D investment reflects the organization's eagerness to ignore current profit in order to improve future performance or returns [10]. The impact of R&D on current productivity crucially depends on the past R&D investments. A main feature of using the firm's R&D stock is that it operates as an indicator of both present knowledge of the company and its past experience with R&D efforts and commercialization of the R&D outcomes. R&D department creates opportunities to make larger profits by using innovative activities. Studies reveal that firms which apply persistent R&D perform better than companies with occasional as well as no R&D. Indeed, R&D strategies have a great impact on the companies' performance and positively affect the profitability and productivity level [11].

C. *Common Types of R&D Activities in Iran Industrial Sector*

Surviving in the fast-changing global market necessitates a wide extent of research and development that would be started by research phase, then turning it into a useful product which is the development phase. R&D activities basically help the companies to discover new knowledge about products, processes, and systems and apply that science to improve current products or create new artifacts to meet market demands. However, Research and Development as a key success factor of country's industrial development must operate based on an appropriate approach [9]. According to the studies [9], the most common types of R&D activities in Iran industrial sector are recognized as follows:

- Formulation reform
- Upgrading productivity
- Replacement material
- Energy change
- Redesign
- Reduction in waste
- Cost reduction
- Reducing environmental pollution
- New product development
- Localization and local content

Fig. 1 shows the percentage of common types of R&D activities in Iranian industrial sector. The data of this figure were obtained from an investigation on Mazandaran, a province of northern Iran [9]. Based on the secondary data, a total of 18 percent of the R&D activities were centralized on upgrading productivity and 14 percent concentrated on cost reduction.

Considering the economic crisis in Iran, a higher proportion of R&D activities were focused on upgrading productivity and cost reduction while the least percentage concentrated on redesign and replacing material.

It can be inferred that due to the high risk investment, high cost, and the weakness of management, the mentioned activities were listed as the least common types of R&D activities in Iran.

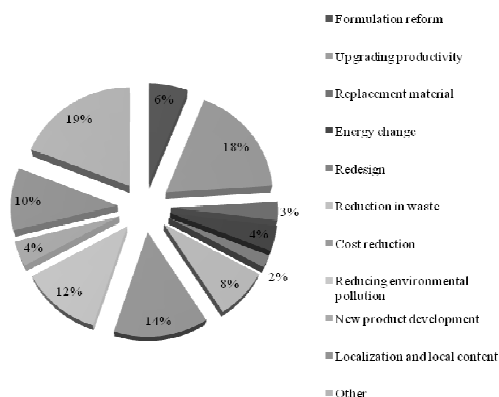


Fig. 1 Common types R&D activities in Mazandaran[9]

D. Industries Benefit the Most from Active R&D Units in Iran

The widespread globalization and the rapid technological changes force technology-based firms to adjust their R&D structure, processes and systems. Fig. 2 depicts the proportion of industries that have been registered as active R&D unit in Iran [9]. A greater percentage of metallic, machinery and equipment design, and automotive industries have benefited from active R&D units while textile, electronic, food, and pharmaceutical industries have the least R&D activities.

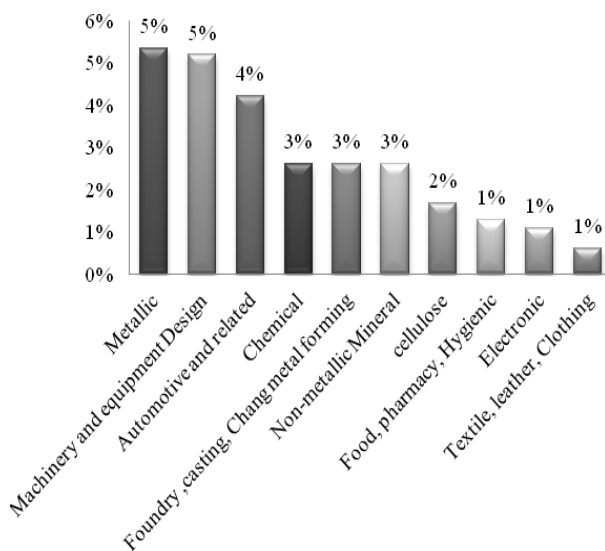


Fig. 2 Industries benefit the most from active R&D units in Iran [9]

III. METHODOLOGY

The main purpose of this research is to investigate the effective factors in R&D growth and to explore the role of R&D management in enhancing social innovation and productivity improvement in Iran industrial sector.

The information of the study was retrieved from primary and secondary data. The primary data were collected through qualitative interview with five key players (Managing Director, Internal Manager, General Manager, Executive Manager, and Project Manager) in the industrial sector while the secondary data obtained from an investigation on Mazandaran, a province of northern Iran [9].

IV. FINDINGS AND DISCUSSION

A. Obstacles to R&D in Iran

Whereas, R&D has resulted in enhancement of social innovation and productivity improvement in Iran industrial sector, transfer of contemporary knowledge into the international market is still lacking. Generally, low budget dedication and insufficient supply of highly skilled scientists and engineers are two important obstacles for R&D in Iran.

• Low-Budget Dedicated

Every successful business was allocated certain amounts of resources to new products and services. Investment in R&D and profitability can be linked in three different ways. First, successful R&D leads to creating new products, which can greatly add to the company's profit. Second, the profits earned by the firm serve as a source of funds to support R&D investments.

Third, managers' expectations of future profit opportunities that are tempered by contemporary market conditions may exert a demand-pull impact on R&D investments.

Today, although large companies spend millions of dollars in speculative research and testing new techniques and processes to enhance their capabilities [12], still most firms in Iran spend only a small percentage of their revenue on R&D. Indeed, low budget dedication is one of the most important obstacles for R&D in Iran.

In the last two decades, the R&D expenditures in Iran were fluctuated between 0.2 and 0.4 percent of Gross Domestic Product (GDP). Table I shows the R&D investment as a percentage of GDP in Iran compare to some developed countries. According to R&D Society of Iranian Industries and Mines 2006, Iran R&D spending has been lagging too far behind developed countries.

TABLE I
R&D EXPENDITURE (% OF GDP) IN IRAN AND SOME DEVELOPED COUNTRIES

Country	1999	2000	2001	2002
Germany	2.43	2.49	2.50	2.52
Iran	0.34	0.31	0.38	0.52
Japan	2.96	2.99	3.07	3.12
Korea, Rep.	2.25	2.39	2.58	2.53
U.S.A.	2.64	2.71	2.73	2.65

• Insufficient Supply of Professional Human Resources

Human resources play a critical role in achieving superior performance in competitive priorities, such as low cost, quality, delivery, flexibility, and innovation. The role of highly skilled workforces in decision-making process is very important, especially with regards to R&D projects that performance and result strongly depend on manpower capabilities.

In R&D department that several projects may have to be implemented simultaneously by a limited number of human workforces [13], professional labours with different skills play a crucial role in successful creations of innovative products.

Insufficient supply of highly skilled scientists and engineers is another important obstacle on the way of R&D growth in Iran. Although, there are potential work forces conducting research in the industrial sector, limited infrastructure for R&D and lack of trained human resources are troublesome. Table II reveals the number of researchers per million in Iran compare to some developed countries. The data are retrieved from World Development Indicators, 2006. Iran with 484 scientists and researchers in R&D sector is so far behind the developed countries.

TABLE II
RESEARCHERS IN R&D (PER MILLION PEOPLE):1990-2003

Country	Germany	Iran	Japan	Korea, Rep.	U.S.A.
Researchers	3,222	484	5,085	2,979	4,526

B. Effects of R&D on Productivity Improvement

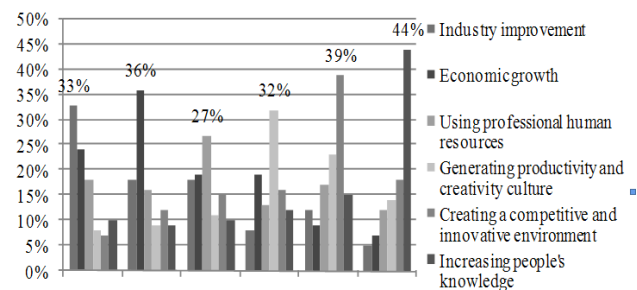
Technological change is a significant determinant of long-run productivity growth and consequently of improvement the living standards over time. Advances in technology are resulted from innovation, which is the process of creating new products, improving current products, or reducing the production cost of existing goods. The importance of research and development for new discoveries is not ignored to anyone. Many analysts have studied the connection between spending on R&D and productivity growth. A large number of empirical studies estimate the effect of R&D investment on such growth. The impact of R&D on productivity is exceeded those of other types of investments by a large margin. A consensus is formed around the view that R&D spending has positive effect on productivity growth with a rate of return that is even slightly larger than the rate of return on conventional investments. Estimating the private and social return to R&D strongly suggests that spending heavily on research and development contributes to productivity growth but the difficult association with measurement and estimation make it hard to garner significant outcomes [14].

Based on the primary and secondary data, most R&D activities in Iran industrial sector have focused on cost reduction and upgrading productivity. Furthermore, the results of the study show the most common effects of R&D on productivity improvement in rank order, industry improvement, economic growth, using professional human resources, generating productivity and creativity culture, creating a competitive and innovative environment, and increasing people's knowledge.

According to the results, industry improvement is the most important effect of R&D in productivity enhancement in Iran industrial sector. It implies that an active R&D unit can invent innovative systems and techniques to improve the industry. Then, by developing new products and exporting them to different countries, the company can grab higher global market share.

Then, economic growth is identified as the second impact. Based on the economic theory that emphasizes on the accumulation of R&D and human capital in explaining economic growth, output will increase when the level of R&D input increases [15].

Using qualified and professional human resources in R&D sector is classified as the third important factor, which positively influences productivity improvement. Moreover, R&D improves productivity and creativity culture by inspiring the employees to invent new systems, processes, and techniques to manufacture high quality and most novel products. Besides, building an innovative and competitive environment where competition is embraced has a great impact on productivity development in the industrial sector. In fact, R&D sector as a center for innovation plays a crucial role in meeting new market demands. Lastly, availability of new products can increase people's knowledge about the latest technologies and consequently improves the society. Fig. 3 indicates the important effects of R&D on productivity improvement with respect to the higher percentage.



1: The Most Important Effect of R&D on Productivity Improvement

6: The Least Important Effect of R&D on Productivity Improvement

Fig. 3 The most common effects of R&D on productivity improvement

V. CONCLUSION

In exploring the role of R&D management in productivity improvement in Iran industrial sector via primary qualitative interviews and secondary data, we conclude that an efficient R&D management greatly affects productivity improvement in industrial sector. R&D efforts need to be further enhanced for the purpose of industry improvement, economic growth, abundance of high-skilled workforce, and rise of the creative, competitive and innovative culture. If Iran could be freed from political impediments, its social innovation may have improved even further and hence contribute to globalization and modernization within the region. Undoubtedly, R&D implementation has resulted in improvement of Iranian society and transfer of contemporary knowledge from the scientists into the international market. Yet, these existing efforts reflect a lapse in comparison to Malaysia, Thailand and other various developing nations. Indeed, low budget dedication and insufficient supply of highly skilled scientists and engineers are two major obstacles to R&D in Iran. The economic embargo and heightened phenomenon of brain drain in Iran is a critical matter, which needs to be researched hand in hand with R&D. This is one of the possible investigations that social innovators may endeavour in future.

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