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Investigating the Effect of Research and Development Contribution to Productivity Growth in SMEs

[1]Amir Hossein Amirkhani, [1]Abolfazl Allahyari and [2]Hossein Torangan
[1]Payame Noor University, P.O. Box, 19395-3697, Tehran, Iran
[2]Department of Management, Payame Noor University, P.O. Box, 19395-3697, Tehran, Iran

Abstract: Currently, Research and Development (R&D)is the most important factor of new productions and industrial achievement of an economy. Moreover, development of SMEs is key to economic development in the next decade. The main purpose of this study is to evaluate R&D for the factors effective on productivity growthof SMEs. In this regard, the factors effective on productivity were first identified and then prioritized from the viewpoint of manufacturers. This study assumed a relationship between R&D and consequently its main dimensions such as human resources and motivation, rules and regulations, innovative R&D, finance and investment and managerial resources and organization and productivity growth. This study used correlation and data was collected by archival and field studies (questionnaires). The studied population consisted of all Iranian SMEs which had R&D units. Using Cochran formula, 320 unitswere selected as samples by simple random sampling method. The results showed a significant relationship between human resources and motivation, rules and regulations, innovative R&D, finance and investment, managerial resources and organization and generally R&D and productivity growth of firms. Moreover, the prioritized dimensions of R&D included finance and investment, managerial resources and organization, innovative R&D, rules and regulations and human resources and motivation, respectively.

Key words: Research and development, productivity, small firm, medium firm, resources

INTRODUCTION

Recently, research along with research centers have been the integral part of the sustainable development of each economy. Currently, organizations have to change and use the latest technological advances to achieve the highest levels of improved abilities to maintain their presence in the competition. In this regard, research and development (R&D) units are the most effective organizational departments which cause rapid changes in current world. Calculation of productivity helps understanding the level of productivity in the organization and identifying areas in need of treatment by a deeper investigation. In Iran, productivity indicators do not indicate a certain condition. This requires efforts to form a national firm determination to get out of a situation in which we were caught. The government plays a vital role in economic growth and productivity. However, the role played by the government, in practice, does not correspond with actual needs. The important role of government is to provide the required infrastructure and opportunities for economic growth including education, health, housing, communications, research and development and available technology. Progress of the growing developments in current business environment puts small and medium-sized units as a part of global production networks and chains which are characterized by technological capabilities, skilled labor and advanced management. Development of small and medium industries is key to economic development in the next decade. Therefore, the movement to organize and assist small and medium industrial units should not be viewed as a rent-seeking grouping but improving factor of industrial structure and competitiveness of this structure for future challenges. Competitiveness is the best answer to the chronic problem of unemployment. Small and Medium-sized Enterprises (SMEs) are characterized by less capital intensiveness, high employment, domestic resources used and environmental adaptability. Their competitiveness as well as their effective partnerships in subcontracts, particularly their high flexibility and innovation has led many countries to consider SMEs, their growth andintegration with large industrial firms. In fact, SMEs with their low resources, yet advanced technology and high knowledge of entrepreneurs and professionals, create things which large firms cannot create by their own. In addition to their previous functions, SMEs are considered as the main focus of

Corresponding Author: Amir Hossein Amirkhani, Payame Noor University, P.O. Box, 19395-3697, Tehran, Iran

technological development to meet the advanced and complex needs of economies. As a result, SMEs require higher flexibility and global environmental adaptability, creativity and innovative structureto enter the global competition. In this way, R&D units play an important role. Hence, the main objective of this study is to evaluate R&D for effective factors of productivity growth in SMEs. In this regard, the factors effective on productivity are first identified and then prioritized from the viewpoint of manufacturers.

Theoretical background

Research and development: Currently, R&D and innovation are main factors ofindustrial promotion, growth, prosperity and welfare of society (Hornung, 2013). Increasing effect of R&D activities on economic growth has led many governmentsto considerboth traditional public measures of support for R&D and new mechanisms to expand and improve these activities. Since, the World War II, R&D has been recognized as the main source of growth and transformation of industrial societies. Currently, new organizations try tocreate regional advantage networks for each activity. These networks include a wide range of business and network processes which are internally consistent with organizational goals. These networks are designed to link capabilities of the core organization to regional departments, achieve R&D competitive advantage and acquireinnovative and competitive structures for an actually global organization. R&D refers to identification ofrequired or potential foundation of thoughts, creation, design, engineering, production, introduction and release a product, process or new technological system. R&D plays a significant role in development of information and communications technology. R&D units are of great importance to promote scientific purposes or develop and carry out R&D-based activities related to the technologies used, tools, methodologies and products in terms of implementation and application in various projects. R&D isa major industrial activity. Technology results from R&D; thus, R&D unitsunderlietechnology. R&D is the largest single source of innovation.

Ultimate goal of R&D organizations is innovation (Broekel, 2015; Acosta *et al*., 2015). In these organizations, strategic functions are based on project. Therefore, new projects are the main focus of R&D organizations. High-tech industries use expert and educated human resources, mostly with experience in the fields of engineering or basic sciences. Zare and Zahedi define R&D process consisting of four distinct but interrelated steps as follows: recognizing the need for innovation; determining the potential applications for new findings and exploring current activities in order to introduce new knowledge (this phase is also called technological knowledge) performingproduct engineering activities (creation, design and experimental production) marketing product and initial application and disseminating ideas. Major problems of R&D unitsinclude R&D costs, shortage of R&D resources and industrial structure of R&D.

Productivity: More than two centuries ago, the term productivity was first used in an agricultural magazine. Since then, the term has been used in different cases, particularly for systems. Although, the concept of productivity has long existed, a significant number of people who make decisions every day about improving efficiency of industrial units do not know how to answer this simple question: what is productivity (Bagheri, 2007). The role of technology, employees and managers in improving productivity can be assimilated toa triangular in which the upper side is directed to the Productivity growth (Poor, 1999). The main purpose of measuring productivity is to improve and increase productivity. In addition to this, the following objectives are pursued: informing (acquiring information on status quo); evaluating problems (identifying opportunities and dealing with threats); creating a mechanism for feedback and encouraging human resources creating information for a variety of managerial decisions.

Improving productivity is the main responsibility of management. Increasing productivity is not possible except by understanding and analyzing it. By measuring productivity, positive or negative trend of a company is recognized. Measuring productivity helps us to understand opportunities and factors effective in improving productivity and implement them to improve productivity. The results of measurements can be raised in improvement sessions. Members of brainstorming sessions can raise the causes of productivity and improvement methods. This can be analyzed, defined and implemented as productivity improvement projects in work plans of various departments (Sanati and Einabadi, 2007). The factors effective on productivity include those factors effective on labor productivity, selection of managers, management efficiency and stability, development of technology and R&D (Taheri, 2005). R&D promotes productivity through both increased technological innovation and increased potential technological imitation. R&D enhances technological transfer capacity. However, efficiency of technological imitation is reduced when approaching the border of the technology of developed economies; in this case, innovation is more important to reduce the technological

gap. Chen *et al*. (2015) showed that focus on R&D could lead to productivity growth. Chen *et al*. (2015) also noted that R and D focusing on innovative processescouldlead to productivity growth for the organization.

Small and medium-sized enterprises: Small and Medium-sized Enterprises (SMEs) are businesses classified in lower levels than largebusinesses. Most common indicator to define the size of SMEs is the number of employees. Although, this number is different in different countries, most countries define SMEs with a certain number of employees ranging from 1-250. In Asia, different quantitative criteria, including the number of employees, value of assets, annual turnover rate and amount of capital, are used to classify SMEs. As defined by the Europe Union, SMEs are manufacturing and service businesses with <250 employees. By this definition, SMEs are categorized as follows:

- Micro firms (1-9) workers
- Small firms (10-49) workers
- Medium-sized firms (50-249)

Small firms have higher flexibility, entrepreneurship, creativity and innovation. They can easily adaptto the rapid environmental changes and react faster to environmental factors such as socio-economic, technological, political and legal factors. SMEs often provide large firms with specialist human resources. Many countries pay special attention to this group of firms. By studying their problems, these countries try to use various advantages provided by SMEs.

To show the role of R&D in an enterprise, diagrams indicate that R&D leads to developed technology, diversified production, increased quality, improved distribution and increased relative advantage. Moreover, innovation and R&D are interrelated; innovationleads to R&D underlies innovation. This reduces production cost and causes productivity growth in an enterprise and transfers technology from one firm to another. Therefore, it will lead to value added growth in the overall economy. R&D is different in different countries operationally. In developed countries, one out of two researchesis implemented, while this ratio is very low in developingcountries. It is essential to consider a budget for implementing research results to support entrepreneurs and SMEs.

Research and development in iran: The figures related to R&D indicatorspublished in the annals of UNESCO reflect the fact that R&D spending to GDP ratio is lower in Iran than in other selected countries. This ratio is high in developed countries (usually>2). In Iran, this ratio is <1. Another significant difference is distribution of GDP on R&D in the public sector; this difference indicates that most activities including R&D are government-related. However, the general upward trend of R&D indicators suggests the increasing optimality and significance of R&D.

Table 1: Ten-year changes in the index of labor productivity in certain Asian countries (1986-1995)

Country	Iran	China	India	Malaysia	South Korea	Pakistan	Japan
Compared to 1986	106.49	165.79	144.59	142	183.61	177.84	131.19

SME definition in Iran: In Iran, there is little consensus on definition of SMEs. Various ministries, institutions and related organizations described, categorized and defined SMEs separately. As defined by the Ministry of Industries and Mines and the Ministry of Agriculture, SMEs are industrial and servicing businesses with <50 workers. The Ministry of Cooperatives, Labour and Social Welfareoccasionally uses the definitions the Ministry of Industries and Mines. Statistical Center of Iranclassifies businesses into 4 groups including businesses with 1-9 employees with 10-49 employees, with 50-99 employees and with >100 workers. Although, this classification seems to resemble the Europe Union definitions of SMEs, Statistical Center of Iran only considers businesses with <10 peopleas SME. Central Bank of Iran also considers businesses with less than 100 workers as SME (Shaghaghi and Shafiei, 2007).

Productivity of SMEs in Iran: Sustainable competitive advantage depends on productivity, quality and innovation. Generally, productivity of SMEsis lower in Iran than in other developing countries. A long-term analysis by the Asian Productivity Organization (APO) shown in Table 1 reflects the low progression of productivity.

Table 1 shows that labor productivity of Iran is <1% per year. Moreover, level of labor productivity considering the value added per capita to constant prices is low.

MATERIALS AND METHODS

This study examined the relationship between components of R&D activities on productivity as dependent and independent variables using a descriptive methodology. This study also usedthe correlation test to analyze the relationships between independent and dependent variables. Datawas collected byarchival and field methods (questionnaire). The studied population consisted of 1830 Iranian SMEs with R&D units. Sample

size (320) was determined by the Cochran formula; the samples were randomly selected. Descriptive statistics were used toanalyze demographic variables; then, inferential statistics were used to analyze hypotheses. Hypotheses were tested by the software SPSS and Pearson correlation coefficient.Variables were prioritized by Friedman test. Because no standard questionnaire was available, two questionnaires previously developed and evaluated for reliability in various studies were used for the current study. One of the questionnaires evaluated R&D and descriptive variables and the other measured the factors effective on productivity. A 55-item questionnaire was used. This questionnaire was evaluated for its content by six faculty members and industry experts. Cronbach's alpha test was used to measure reliability; β-value was >0.7 for all variables. Hypotheses and sub-hypotheses are listed as.

Sub-hypotheses:

- There is a relationship between human resources and motivation and productivity growth
- There is a relationship between rules and regulations and productivity growth
- There is a relationship betweeninnovative R&D and productivity growth
- There is a relationship betweenfinance and investment and productivity growth
- There is a relationship between managerial resources and environmental organization and productivity growth

Hypothesis: There is a relationship between R&D units and productivity growth. Overall, this study has four main categories of independent variables as follows:

- Equipment and capital or hardware
- Employees
- Managerial factors
- Research and innovation context
- Information and communication factors

Above factors were measured by a 55-item questionnaire. Finally, effect of R&D was evaluated on the factors influencing productivity. In this study, total productivitywas considered as the dependent variable.

RESULTS AND DISCUSSION

Demographics: Educational level of participants ranged from high school diploma(4.1%), bachelor's degree (25.9%), master's degree (49.7%), to PhD (20.3%). Participants had a year or less(6.3%), 2-4 years (27.5%), 4-7 years (44.1%)andover 7 years (22.2%) of experience. The scores obtained by the participants for human resources and motivation ranged from very low (6.6%), low (9.4%), average (50%), high (6.92%) to very high (7.2%). The scores obtained by the participants for rules and regulations ranged from low (16.6%), average (64.7%), high (18.1%) to very high (0.6%). The scores obtained by the participants for innovative R and D ranged from very low (61.3%), low (20%), average (13.1%), high (4.1%) to very high (1.6%). The scores obtained by the participants for finance and investment ranged from very low (5.6%), low (9.7%), average (30.6%), high (26.9%) to very high (27.2%). The scores obtained by the participants for managerial resources and environmental organization ranged from very low (21.9%), low (9.7%), average (36.6%), high (25%) to very high (6.9%).

Relationship between demographic variables and dependent variable: Relationship between Education and R&D Components As shown in Table 2, df = 6, $\chi^2 = 17.876$ and Sig. = 0.007. This difference is significant and generalizable to the whole population.

Relationship betweenexperience and R&D components: As shown in Table 3, df = 4, $\chi^2 = 9.102$ and Sig. = 0.168. This difference is not significant and generalizable to the whole population. There is no relationship between experience and R&D components.

Hypotheses:

Sub-hypothesis 1: There is a relationship between human resources and motivation andProductivity growth. As shown in Table 4, df = 4, $\chi^2 = 224.781$ and Sig. = 0.000.

Sub-hypothesis 2: There is a relationship between rules and regulations and productivity growth.

Table 2: Chi-square test; the relationship between education and R&D components

Tests	χ^2	df	Sig.
χ^2	17.876	6	0.007
Likelihood	19.369	6	0.004
Linear-by-linear association	1.614	1	0.004

Table 3: Chi-square test; the relationship between experience and R&D components

Tests	χ^2	df	Sig.
χ^2	9.102	6	0.168
Likelihood	9.672	6	0.139
Linear-by-linear association	1.012	1	0.315

Table 4: Relationship between human resources and motivation and productivity growth

Values	Sample observed	Sample expected	Residual
1	21	0.64	-0.430
2	30	0.64	-0.034
3	160	0.64	0.960
4	86	0.64	0.220
5	23	0.64	-0.410
Total	320		

Chi-square test: $\chi^2 = 224.781$; df = 4; Asymp. Sig. = 0.000

Table 5: Relationship between rules and regulations and productivity growth

Values	Sample observed	Sample expected	Residual
2	53	80	-27
3	207	80	127
4	58	80	-22
5	2	80	-78
Total	320		

Chi-square test: $\chi^2 = 292.825$; df = 3; Asymp. Sig. = 0.000

Table 6: Relationship between innovative R and D and Productivity growth

Values	Sample observed	Sample expected	Residual
1	196	0.64	0.132
2	64	0.64	0.000
3	42	0.64	-0.220
4	13	0.64	-0.510
5	5	0.64	-0.590
Total	320		

Chi-square test: $\chi^2 = 374.844$; df = 4; Asymp. Sig. = 0.000

This difference is significant and generalizable to the whole population. There is a relationship between human resources and motivation and productivity growth. As shown in Table 5, df = 3, $\chi^2 = 292.825$ and Sig. = 0.000. This difference is significant and generalizable to the whole population. There is a relationship between rules and regulations and productivity growth.

Sub-hypothesis 3: There is a relationship between innovative R&D and productivity growth. As shown in Table 6, df = 4, $\chi^2 = 374.844$ and Sig. = 0.000. This difference is significant and generalizable to the whole population. There is a relationship between innovative R&D and productivity growth.

Sub-hypothesis 4: There is a relationship between finance and investment and productivity growth. As shown in Table 7, df = 4, $\chi^2 = 83.969$ and Sig. = 0.000. This difference is significant and generalizable to the whole population. There is a relationship between finance and investment and productivity growth.

Sub-hypothesis 5: There is a relationship between managerial resources and environmental organization and Productivity growth. As shown in Table 8, df = 4, $\chi^2 = 93.031$ and Sig. = 0.000. This difference is significant and generalizable to the whole population. There is a relationship between managerial resources and environmental organization and productivity growth.

Hypothesis: There is a relationship between R&D units and productivity growth. As shown in Table 9, df = 2, $\chi^2 = 142.131$ and Sig. = 0.000. This difference is significant and generalizable to the whole population. There is a relationship between R&D units and productivity growth.

Table 7: Relationship between finance and investment and increase productivity

Values	Sample observed	Sample expected	Residual
1	18	0.64	-0.46
2	31	0.64	-0.33
3	98	0.64	0.34
4	86	0.64	0.22
5	87	0.64	0.23
Total	320		

Chi-square test: $\chi^2 = 83.969$; df = 4; Asymp. Sig. = 0.000

Table 8: Relationship between managerial resources and environmental organization and productivity growth

Values	Sample observed	Sample expected	Residual
1	70	0.64	0.60
2	31	0.64	-0.33
3	117	0.64	0.53
4	82	0.64	0.16
5	22	0.64	-0.42
Total	320		

Chi-square test: $\chi^2 = 374.844$; df = 4; Asymp. Sig. = 0.000

Table 9: Relationship between R&D units and productivity growth

Values	Sample observed	Sample expected	Residual
3	62	1.067	-44.7
4	207	1.067	100.3
5	51	1.067	-55.7
Total	320		

Chi-square test: $\chi^2 = 142.131$; df = 2; Asymp. Sig. = 0.000

Table 10: Relationship between managerial resources and environmental organization and productivity growth

Priorities	Mean rank
Finance	3.91
Management	2.93
Innovation	1.63
Rules	3.18
Human	3.35

Friedman test: $\chi^2 = 427.215$; df = 4; Asymp. Sig. = 0.000; Kendall test: Kendall's W = 0.334; $\chi^2 = 427.215$; df = 4; Asymp. Sig. = 0.000

Prioritization of R&D components: As shown in Table 10, Freedman test and Kendal test indicate a relationship between R&D components. This relationship is confirmed bythe Friedman and Kendall test (Sig. = 0.00). Accordingly, the priorities are reliable, as follows:

- Finance and investment
- Managerial resources and environmental organization
- Innovative R&D
- Rules and regulations
- Human resources and motivation

Primarily, promotion of technical knowledge depends on R&D at all levels including industry. Currently, creativity, initiatives and innovation are the greatest assets of industrial companies. Moreover, productivity improvement is the main responsibility of management. Increasing productivity is not possible except by understanding and analyzing it. By measuring productivity, productivity of a manufacturer is recognized.

Productivity measurement helps identifying opportunities and factors effective in improving productivity and implementing them to improve productivity. The present study evaluated the effect of R&D on the factors influencing the Productivity growth of SMEs. The results of data analysis confirmed the main hypothesis thatthere is a relationship between R&D units and productivity growth; that is, there is a significant relationship between R&D units and productivity growth. The results also confirmed sub-hypotheses; that is there is a significant relationship between human resources and motivation, rules and regulations, innovative R&D, finance and investment, managerial resources and environmental organization and productivity growth.

CONCLUSION

Finally, a comparison was made between level of the relationship between different R&D components and productivity growth to prioritize those components in relation to the Productivity growth. The results showed that finance and investment, followed by managerial resources and environmental organization, innovative R&D, rules and regulations and human resources and motivation, had the highest effect on productivity growth, respectively.

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