**Identifying and Prioritization Effective Factors on performance appraisal of R&D sector by AHP technique
(Case Study: production units of guilan Province)**

Amid Pourghafar Maghferati[1*] , Allahyar Daghbandan [2] , Mahmoud Modiri [3]

[*1]Department of Industrial Management, Qazvin branch, Islamic Azad University (IAU), Qazvin, Iran
E-mail: a.pourghafar@qiau.ac.ir
[2]PhD, Assistant Professor, Faculty of engineering, University of guilan, guilan, Iran
[3]PhD, Assistant Professor, Faculty of accounting and Management, South Tehran Branch Islamic Azad University
(IAU), Tehran, Iran   E-mail: m.modiri@gmail.com

Abstract: Today, research and development activities are main factor for economic and industrial development to all firms. Developing countries to get to the level of developed countries would be in R&D units and its research activities, new strategies are developed at the university level whether in the public sector and small and large production units. The purpose of this study is Identifying and Prioritization Effective Factors on performance appraisal of R&D sector by AHP technique. The results show that financial aspect is the most important factor that influence on performance appraisal of R&D units and moreover, the less important factor is research performance that influence on performance appraisal of R&D units.
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1. Introduction

In the last decades academic and managerial literature have paid growing attention to the problem of measuring business performance (Amadio, 2005), because it has been recognised to be a critical issue for motivating personnel, supporting decision making, fostering organisational learning and continuous improvement (Sink, 1991). Although R&D was once considered as an uncertain, unpredictable and unstructured process that it was almost impossible to control, recently it has been thought of as an accountable one (Kerssens-van Drongelen and Cook, 1997). According to Global R&D Report (2005) the effects of outsourcing, insourcing, and shifting political landscapes will bolster global R&D efforts. The firm-level research projects can be seen as first stage in a sequential process that lead to the creating of new knowledge which transforms into new products or processes by mean of further development in a firm. The patents which are filed during the development stage provide protection to a firm against patent infringement. The patents, in a broader sense, reflect the final result of a firm's research and development (R&D) project (Ernst, 1998) which yields economic benefits such as competitive advantage and high market share. Most of the previous studies have either examined the impact of tax incentives, product market competition (Bloom et al., 2002; Blundell et al., 1999), and public policies (Jaumotte and Pain, 2005) on the firm-level R&D. The literature review is structured around several themes

connected with organising and controlling R&D in Iran. These themes include forms of control through the impact of a modern dynamic environment on goal setting, location, structure and organisation of R&D, staffing processes and relationships among the players. As with any management, managing R&D is directed to achieving the optimum for the organising and controlling efforts applied to the activities. These goals have been impacted by deregulation, blurring boundaries and the convergence of industries and technological discontinuities where many organisations have been forced into simultaneously re-inventing themselves as information and communication technology (ICT) industries. Today's R&D managers refer a lot to history, and although industrial research takes place in ever changing organizational settings, as this paper will show, it seems as if each new generation of R&D leaders has to deal with the same kind of problems. It has been known for decades already that one of the bottlenecks in doing R&D in industry is the difficult relationship between research activities and the production of goods (Mokyr, 1990; Nelson, 1996; Freeman and Soete, 1997).

The measurement of R&D performance requires also that the specific dimensions to be monitored are adequately selected (Chen et al.; Kerssen-van Drongelen and Cook, 1997; Stainer and Nixon, 1997). The number of alternative performance dimensions is almost infinite and literature has advanced different taxonomies. Schumann et al. (1995) distinguish between: Input; . Process; and Output measures.

Chiesa and Frattini (2007) speak of Effectiveness; Efficiency; Contribution to value; and Time.

Bremser and Barsky (2004), suggesting the adoption of the Balanced Scorecard in R&D settings, identify four perspectives: (1) economic-financial; (2) customer; (3) innovation and learning; and (4) internal business. The global context in which firms develop and implement business strategies has changed significantly. The knowledge-based economy has made multinational companies increase the transfer of innovation processes to their foreign subsidiaries in order to adapt their products and services to local needs and to make use of the knowledge locally available. The location of R&D can be attributed to various motives: (1) drivers for the internationalization process; (2) firm's geographic orientation in R&D activities; (3) strategic role of the foreign subsidiary (see Casson and Singh, 1993; Cantwell, 1992). The R&D activities of subsidiaries can be very different. The structure of R&D management also includes sets of relationships developed between R&D and the product related divisions, manufacturing plants or other business units. The architecture of a firm, its organizational characteristics such as boards, committees, policies, career paths, management routines, control mechanisms and project management protocols all impact on the knowledge use and expertise of researchers. The harmonisation of technological and organisational capabilities termed integrative capabilities allow R&D to excel in innovation thus gaining competitive advantage. The influence of national culture on the development of R&D activities is normally related to Hofstede's (1987) cultural dimensions and has been associated with the processes of invention and innovation (Shane, 1993) and new product development (Morris et al. 1994). The influence of local culture on innovation and its importance to R&D competitive advantages has also been pointed out by Nakata and Sivakumar (1996), when they refer that implicit in the selection of any location is the selection of a national culture. One way research and development departments can assess their performance is to determine the extent of their customers' satisfaction. Research and development is a major source of innovation and an important driver of a country's economic growth (Industry Commission, 1994). The extent of customer satisfaction is one way research and development (R&D) performance can be measured.

2. Effective Factors on performance appraisal of R&D sector

The researcher tries to recognize the Effective Factors, which is done through library studies, design and distribution of questionnaire and also interview with different manufacturing companies' experts.finally, Effective Factors on performance appraisal of R&D sector is classified into 7 major criteria and 21 minor criteria. The major criteria symbols in this study are as follows: access Level of Facilities (A), Quality of manpower (B), Financial aspects (C), New product technology (D), Optimization (E), Research performance (F), Customer orientation (G).

The major criteria symbols in this study are as follows:

The level of access to laboratory equipment (A_1), the facility to implemention of knowledge (A_2), Access level of information technology such as Internet (A_3), Level of education (B_1), Number of training courses passed (B_2), Experience (B_3), Budget of R&D units in year (C_1), Salary levels of R&D units staff (C_2), Growth in research funding than last year (C_3), Number of new businesses offered by R&D (D_1), The number of new products offered by R&D (D_2), Number of application innovation in old products (D_3), Energy Consumption (E_1), Reduce waste and emissions (E_2), Reduction in production costs (E_3), Recorded in the number of articles and books (F_1), Participate in seminars and conferences on internal or external (F_2), Patent (F_3), Percentage of lost customers (G_1), Percentage of new customers (G_2), Percentage of using warranty in year (G_3).

3. Analytic hierarchy process (AHP)

AHP is a multiple-objective decision-making analytic method, which combines qualitative analysis with quantitative analysis. It is applicable to the decision-making problems that have comparatively complex structure and multiple decision-making criteria and are not easy to quantify. AHP users first put forward a general target according to the nature and requirement of the problem; then they decompose the problem into sub-problems according to hierarchies. Pairwise comparison is used to determine the weight coefficient of each factor in the same hierarchy to the upper target. The same analytic pattern is applied to every hierarchy until the last one, and then a rank-ordering of all the factors is achieved based on their importance to the general target. This method organizes factors in a complex problem by dividing them into orderly hierarchies that are related to each other and, based on judgment drawn from actual project, quantitatively indicates the relative importance of each hierarchy; then it uses mathematical method to determine the weights that express the relative importance order of all the factors in each hierarchy and solves the problem by analyzing the ordering result. To check the consistency among

judgment matrix of different order, one compares the judgment matrix consistency deviation indicator a with average random consistency indicator C.I. When C.I < 0.10, judgment matrixes has satisfying consistency, otherwise adjustment needs to be made.

4. Research metodology

Given the goal of this research that is Identifying and Prioritization Effective Factors on performance appraisal of R&D sector by AHP technique, this is done in two stages. In first stage, the researcher tries to recognize the Effective Factors, which is done through library studies, design and distribution of questionnaire and also interview with different manufacturing companies' experts, during which Effective Factors on performance appraisal of R&D sector is classified into 7 major criteria and 21 minor criteria, according which the decision tree hierarchy (Fig 1) is designed. In second stage, the researcher decisions matrix in order to ranking the recognized criteria. In order to gather these data, another questionnaire is designed and distributed among 13 experts.

Fig1. Hierarchical tree for performance appraisal of R&D units

5. Data analysis

Here, the data achieved from Analytical Hierarchy Process (AHP) are depicted in the form of the following tables:

Table 1: rank and total weights of seven main criteria		
criteria	total weight	rank
Financial aspects	0.447	1
New product technology	0.418	2
Quality of manpower	0.385	3
Customer orientation	0.361	4
access Level of Facilities	0.168	5
Optimization	0.113	6
Research performance	0.108	7

According to the results, experts believe that the most important Effective Factors on performance appraisal of R&D sector is financial aspects, with total weight of 0.447. New product technology is the second factor. Quality of manpower with total weight of 0.385 and Customer orientation with total weight of 0.361 are known as the third and the forth factors from experts' point of view. Moreover, the less important factor is research performance that influence on performance appraisal of R&D units (with total weight of 0.108).

Table 2: ranking the Effective Factors on performance appraisal of R&D sector

main criteria	Weight of the main criteria	sub-criteria	Weigh criteria in sub group	total weight	rank
Financial aspects	0.447	level of access to laboratory equipment	0.355	0.059	15
		the facility to implemention of knowledge	0.232	0.038	18
		Access level of information technology	0.413	0.069	12
New product technology	0.418	Level of education	0.512	0.197	2
		Number of training courses passed	0.253	0.097	9
		Experience	0.235	0.090	10
Quality of manpower	0.385	Budget of R&D units in year	0.565	0.252	1
		Salary levels of R&D units staff	0.250	0.111	8
		Growth in research funding than last year	0.185	0.082	11
Customer orientation	0.361	Number of new businesses offered by R&D	0.372	0.155	4
		The number of new products offered by R&D	0.310	0.129	6
		Number of application innovation in old products	0.318	0.132	5
access Level of Facilities	0.168	Energy Consumption	0.171	0.019	21
		Reduce waste and emissions	0.265	0.029	19
		Reduction in production costs	0.564	0.063	13
Optimization	0.113	Recorded in the number of articles and books	0.207	0.022	20
		Participate in seminars and conferences on internal or external	0.391	0.042	17
		Patent	0.402	0.043	16
Research performance	0.108	Percentage of lost customers	0.352	0.127	7
		Percentage of new customers	0.481	0.173	3
		Percentage of using warranty in year	0.168	0.060	14

The results show that Budget of R&D units in year, Percentage of new customers, Number of new businesses offered by R&D, Number of application innovation in old products , The number of new products offered by R&D , Percentage of lost customers , Salary levels of R&D units staff , Number of training courses passed , Growth in research funding than last year, Access level of information technology, Reduction in production costs , Percentage of using warranty in year, level of access to laboratory equipment, Patent , Participate in seminars and conferences on internal or external , the facility to implemention of knowledge , Reduce waste and emissions , Recorded in the number of articles and books and Energy Consumption are respectively the most important Effective Factors on performance appraisal of R&D sector.

Conclusion

The main focus of R&D management research has been on creating models and tools that help in selecting winning projects from many ideas. Ransley and Rogers (1994) have combined the output from four studies to create a list of seven best practices by which R&D performance can be measured. The seven key performance measures are technology strategies, program selection and management, core strengths, effectiveness, external awareness, technology transfer and personnel. Several studies have documented the relevance of R&D in determination of a firm's market value. Chan et al. (1990) find a significantly positive market reaction to announcements of increased R&D. Sougiannia (1994) find that a one- dollar increase in R&D expenses leads to a five- dollar increase in market value. The purpose of this study is Identifying and Prioritization Effective Factors on performance appraisal of R&D sector by AHP technique. The results show that among the main factors, financial aspects, new product technology, Quality of

manpower and Customer orientation are respectively the most important Effective Factors on performance appraisal of R&D sector. Moreover Among the sub-factors, Budget of R&D units in year, Percentage of new customers, Number of new businesses offered by R&D, Number of application innovation in old products and the number of new products offered by R&D are respectively the most important Effective Factors on performance appraisal of R&D sector. Future study can identify and ranking Effective Factors on performance appraisal of R&D sector by different methods such as ELECTRE, TOPSIS and VIKOUR.

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