

PRIORITIZING THE GOALS OF STRATEGIC MANAGEMENT OF RESEARCH AND DEVELOPMENT BY THE ANALYTICAL HIERARCHY PROCESS (AHP); CASE STUDY: TABARESTAN PLASTIC COMPLEX COMPANY

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Abstract

Today, with the growth of science and innovation in the industries, products are being offered in market that have features of complexity and innovation. On the other hand, increase in diversity of customers' needs and increase of competitors have made the markets undergo major changes. Therefore, in order for effective presence in the market, companies need to develop and present new products in a short period of time that have technological diversity. The solution to meet this need depends on the capabilities of the research and development unit in the development and presentation of new products. This article is born from the belief that if the objectives of the research and development unit are well prioritized, they can play an important role in the promotion of organizations. In this article, the objectives of the research and development unit of Tabarestan Plastic Complex Company have been examined in three levels of market, products and production, and the sub-criteria of these three levels have been determined according to the opinion of the managers, in each department. After that, using the hierarchical analysis method (AHP), prioritization of sub-criteria is specified.

Keywords: Innovation in Industries, Research and Development, Analytical Hierarchy Process.

1. INTRODUCTION

Today, with the development of science and technology, the market needs are also increasing; therefore, companies, in order to protect themselves in the new competitive market, have to stop the production and supply of some products, or modify the products, or develop new product (NPD) and respond to this need (Kim and Kumar, 2009).

Therefore, in today's competitive conditions, the research and development unit is the central core and driving engine for the advancement of industries and the factor in maintaining the competitive advantage of organizations.

Therefore, the dynamism and up-to-datedness of these units allow managers to adopt development strategies quickly and correctly (Hemmati et al., 2019). During the last two decades, we have witnessed the expansion of the field of industrial research and the role of research managers in industries; therefore, simultaneously with the growth of strategic management, many research managers have created a more effective connection between their laboratory research results and business needs and they have developed their core capabilities and prioritization of their research laboratories based on the goals and business strategies of

the organization, so it can be said that research managers are always facing two waves of changes that force them to go beyond the limits of the laboratory and look at the activities from a more comprehensive perspective (Hemetpour et al., 2004).

In the first wave of change that started in the early 1970s, the relationship between laboratory research and business strategy is discussed more and more, and the second wave of change is the extent of technology and its increasing impact on global competitiveness capability (Abassi and Abdi, 2012).

Companies and organizations acquire technologies in different ways (Hemetpour et al., 2004):

- Setting up and managing the intra-organizational activities of research and development (R&D) units.
- Direct investment in new equipment and people.
- Technology under license of another company.
- Being active in obtaining patents.
- Cooperation with R&D centers and other research organizations or universities.
- Using the results of public sector research in the field of R&D.
- Establishing technological communication and at the same time necessary R&D measures to enter new areas.
- Training and directing current capabilities and resources in the direction of research and development.

The requirement for the successful development of new products is to know the effective factors in this process and to determine the importance of each factor compared to the other (Abbasi and Abdi, 2013). The more the activities of the R&D unit in the organization are aligned with the goals, strategies and policies of the macro management, the higher the competitive advantage will be created (Mahdavi and Mahdavi, 2004).

Analytical Hierarchy Process is one of the most comprehensive systems designed for decision-making, which is used in this research to prioritize research and development management goals in Tabarestan Plastic Complex Company.

This method is a way to organize information and use it in decision making. In this method, criteria suitable for the subject are selected and then the criteria of the results are combined.

The above process will be used to solve complex problems through the hierarchy of criteria (Samti et al., 2002). Thus, this process is used to classify options and allocate resources.

Hemti et al. (2019) conducted a research titled "Identification and prioritization of success criteria of research and development projects in Iran's oil industry research center using fuzzy analytical hierarchy approach".

The purpose of this study was to identify and prioritize the success criteria of research and development projects in the Iranian Oil Industry Research Institute as one of the largest research institutes in Iran. In this research, first through literature review and semi-structured interviews with experts from the Oil Industry Research Institute, success criteria in research and development projects were identified, then using the fuzzy analytical hierarchy approach, the identified criteria were prioritized.

In this research, 6 technical, organizational, technological- scientific, economic, social and commercial criteria as the main success criteria and 17 sub-criteria were identified. According to the results obtained from the prioritization of the success criteria of the research and development projects of Iran Oil Industry Research Institute, technical criteria, organizational criteria, technological- scientific criteria were the most important criteria, and the sub-criteria of user satisfaction, credit acquisition, compliance with the employer's requirements, and impact on the organization's business were among the most important sub-criteria of success and ranked first to fourth among 17 sub-criteria. Abbasi and Abdi (2012) conducted a study titled "Identification and ranking of effective factors in new product development in Arak Combine Manufacturing Company with hierarchical analytical process".

In this research, first by studying the available documents such as books, magazines and consulting with managers and experts of each department, 4 criteria of technology, marketing, commercialization and research and development team were identified and 5 sub-criteria were defined for each. In the following, through the hierarchical approach, the criterion of the factor "technology" was the most important compared to other criteria, and the sub-criterion "designing and testing with computer" which is under the criterion of technology was also the most important. According to the results obtained from this research, three suggestions were made:

1. Creating a product design team using experts and finding technology-related problems in the current product and solving existing problems.
2. Designing and testing by computer in the process of product testing and production.
3. Creating a suitable platform for commitment orientation and creating motivation for experts and managers in the development team.

The purpose of this article is to prioritize the objectives of the strategic management of the research and development unit with the Analytical Hierarchy Process (AHP) in Tabarestan Plastic Complex Company.

2. CONCEPTS

2.1 Strategic Management

Strategic management is one of the management activities that analyze the important issues of the organization, the goals of the organization and the methods to achieve the goals. This process includes specifying the missions, visions, assets of the organization and developing the plans and policies of the organization (Alanchari, 2023).

In organizations, strategies are defined at three levels (Abbaspour and Sobhani, 2015 and Moazzezi Niko, 2023):

- The level of the whole organization: the purpose of formulating a strategy at this level is to direct the whole complex and optimally allocate resources in it.
- Business level: in large organizations that have different independent units, in line with the strategies of the whole organization, strategies are also determined for each of the organization's units.
- Task level: at this level, based on the goals and strategies of higher levels, a task strategy is determined for each of the tasks of the organization's units. At the task level, a set of strategies may be developed. The main responsibility of managers at this level is to implement the strategies and strategic plans of the organization.

In small organizations, the levels of the whole organization and business are integrated and this type of organization has two levels. In strategic management, quantitative and qualitative information is tried to be adjusted in such a way that effective decisions can be made under uncertain conditions.

The process of strategic management can be divided into four stages (Mahdavi and Mahdavi, 2004 and Alanchari, 2023):

1. Analysis of the situation and environmental review: In this stage, the internal and external factors affecting the organization are analyzed and then the process of collecting, examining and providing information for strategic purposes begins. At this stage, it is necessary for the management to continuously evaluate the internal and external influencing factors and try to improve it.
2. Strategy Formulation: In this stage, the decision making process is carried out regarding the best performance to achieve the goals of the organization. In formulation of strategy, first the set of strategies that can be used are listed and then using strategic management models and according to the results obtained in the situation analysis in the first stage, the best strategy is chosen.
3. Strategy Implementation: implementation of the strategy means application of the desired strategy or the implementation of the selected strategy of the organization. Strategy implementation includes organizational structure design, resource distribution, decision-making process development, and human resource management.
4. Strategy evaluation: strategy evaluation is the final stage of the strategic management process. The evaluation ensures that the organization's strategy and its implementation are consistent with the organization's goals. The need to take corrective action is determined in this section. The information obtained from the strategy search process should be in such a way as to facilitate operations and actions.

2.2 Research and Development

Research and development (R&D) includes a set of creative activities that companies invest in to innovate and introduce their new products and services. In fact, this unit takes the first steps to develop products, advance science in the industry and finally provide high-quality products. In fact, it can be said that research and development forms a stream in which research activities are planned, guided and implemented in order to achieve development goals (Nasiri, 1998 and Zahedi Tabarstani et al., 2004).

2.3 Analytical Hierarchical Process

The Analytical Hierarchical Process is one of the most widely used decision-making methods for ranking and determining the importance of factors which was first invented by Thomas L. Saaty in the 70s. In this method, criteria are selected and sub-criteria are defined for each criterion, then criteria are prioritized using paired comparisons of options. The reason for calling this method hierarchical is that one should first start with the goals and strategies of the organization at the top of the pyramid and by expanding them identify the criteria to reach lower levels (Vaidy and Kumar, 2006).

3. RESEARCH METHOD

This research was conducted in order to prioritize the goals of strategic management of the research and development unit in Tabarestan Plastic Complex Company using the Analytical Hierarchy Process (AHP) which is based on paired comparisons of effective factors and related sub-factors. The current research is practical from the point of view of the goal because its results are directly used to solve a specific problem and the application of the solution method leads to providing special programs to solve the problem in a system. Due to the high capabilities of the Analytical Hierarchy Process, this method has been used in prioritizing criteria (Singh, 2013). The research was conducted with the field method and through consultation with managers and experts in the departments related to product development in Tabarestan Plastic Complex Company; three criteria were selected under the headings of "Market", "Products" and "Production". The sub-criteria determined were as follows:

The sub-criteria of the "market" factor include: "meeting customer needs", "increasing market share", "gaining credibility in the market", "increasing competitive points in the market" and "reasonable price of products in the market".

Sub-criteria of the "Products" factor include: "Production of new products", "Modification of previous products", "Using up-to-date knowledge in products", "Increasing product quality", "Reducing product costs" and "Change in product formulation".

The sub-criteria of the "production" factor are: "increasing efficiency", "reducing production time", "reducing the amount of waste", "reducing equipment failure", "reducing production costs", "change in production technology", "simpler production process" and "reducing possible risks while doing work".

Figure 1 shows the conceptual model of the research. The conceptual model includes three levels:

- The first level: the objectives of the research and development unit
- Second level: criteria
- Third level: sub-criteria

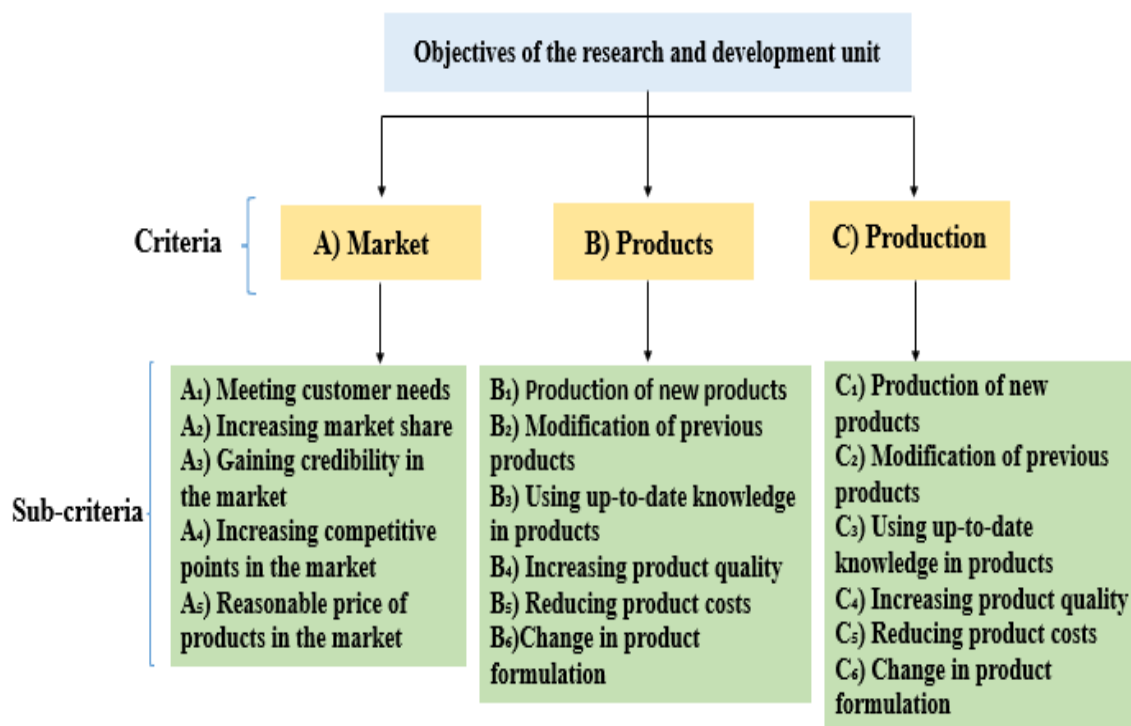


Figure 1: Conceptual Model of the Research

After determining the criteria and sub-criteria of the research, questionnaires were designed for their pairwise comparison and were given to the managers and experts of each unit and they were asked to answer the questionnaires according to Table 1.

Table 1: Scoring Scale of Pairwise Comparison

Preferences (verbal judgment)	Numerical value
Absolutely more important or absolutely more desirable	9
Very strong importance and desirability	7
Strong importance or desirability	5
A little desirable or a little more important	3
Equal importance or desirability	1
Priorities between agents	2,4,6,8

In the matrix of paired comparisons, the elements of the main diameter are all the same, and to fill the matrix of paired comparisons, the scale of 1 to 9 was used to determine the relative importance of each criterion compared to the other. After completing the matrix of pairwise comparisons, the resulting matrices were analyzed by the Expert Choice version 11 software. Finally, the output of the software, the weight of each of the criteria, sub-criteria and their priorities relative to each other were determined.

4. FINDINGS ANALYSIS

The results of the analysis with Expert Choice software include the weight and prioritization of the criteria. In this research, the rate of inconsistency is equal to 0.08, 0.09, 0.08, 0.07 and 0.03, which is acceptable in terms of hourly inconsistency rate less than 0.1 (Abassi and Abdi, 2012). Therefore, it can be concluded that the judgments were correct.

Table 2 includes pairwise comparisons of the second level criteria and Figure 2 shows the diagram of weighting and prioritization of the second level criteria with 0.03 inconsistency. The importance of the following second level criteria is as follows:

1. Products.
2. Market.
3. Production.

According to the weight of each of these criteria, it was found that the importance of factor B (products) is the most important. This issue shows that it is very important to pay attention to the quality of products in the research and development unit of Tabarestan Plastic Complex.

Table 2: Pairwise Comparisons of 3 Criteria of the Second Level

	A	B	C
A		1	3
B			5
C	Incon: 0.03		

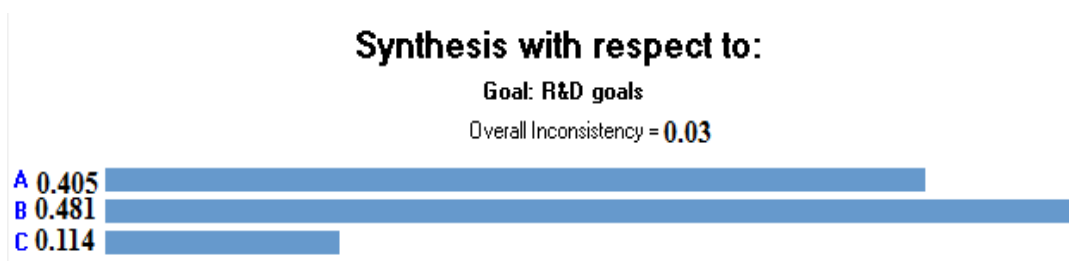


Figure 2: Diagram of Weighting and Prioritization of 3 Criteria of the Second Level

Table 3 includes pairwise comparisons of sub-criterion A and Figure 3 shows the weighting and prioritization diagram of sub-criterion A with an inconsistency of 0.08. The importance of the following criteria is as follows order:

1. Increasing competitive advantage in the market.
2. Gaining credit in the market.
3. Meeting customer needs.
4. Increasing market share.
5. Reasonable price of products in the market.

According to the weight of each of these criteria, it was found that the sub-criterion A4 (increasing the competitive score in the market) is more important than other sub-criteria.

Table 3: Pairwise Comparisons of Criterion A’s Sub-Criteria

	A1	A2	A3	A4	A5
A1		3	1	3	3
A2			3	5	3
A3				1	3
A4					3
A5	Incon=0.08				

Synthesis with respect to: A
 (Goal: R&D goals > A (L0.405))
 Overall Inconsistency = 0.08



Figure 3: Diagram of Weighting and Prioritization of Criterion A’s Sub-Criteria

Table 4 includes pairwise comparisons of sub-criteria of criterion B, and Figure 4 shows the diagram of weighting and prioritization of sub-criteria of criterion B with an inconsistency of 0.09. The importance of the sub- criteria is as following order:

1. Increasing the quality of products.
2. Using up-to-date knowledge in products.
3. Production of new products.
4. Reducing the costs of finished products.
5. Modification of previous products.
6. Change in product formulation.

In these sub-criteria, increasing the quality of products and changing the formulation of products are the most and least important, respectively.

Table 3: Pairwise Comparisons of Criterion B's Sub-Criteria

	B1	B2	B3	B4	B5	B6
B1		3	3	9	1	3
B2			1	9	1	1
B3				9	3	3
B4					7	9
B5						3
B6	Incon=0.09					

Synthesis with respect to: B
(Goal: R&D goals > B (L:0.481))
Overall Inconsistency = 0.09



Figure 4: Diagram of Weighting and Prioritization of Criterion B's Sub-Criteria

Table 5 includes pairwise comparisons sub-criteria of criterion C and figure 5 shows diagram of weighting and prioritization of sub-criteria of criterion C with an inconsistency of 0.08. The importance of the sub-criteria is as the following order:

1. Increasing efficiency.
2. Reducing production time.
3. Reducing the amount of waste.
4. Reducing device failure.
5. Reducing possible risks during work.
6. Reducing production costs.
7. Simplifying the production process.
8. Changing production technology.

In these sub-criteria, the increase in efficiency is the most important and the changing production technology is the least important.

Table 5: Pairwise Comparisons of Criterion C's Sub-Criteria

	C1	C2	C3	C4	C5	C6	C7	C8
C1		1	3	3	3	3	3	1
C2			1	1	1	5	3	1
C3				1	3	3	3	1
C4					1	5	5	1
C5						3	3	1
C6							3	1
C7								1
C8	Incon=0.08							

Synthesis with respect to: C

(Goal: R&D goals > C (L: 0.114))

Overall Inconsistency = 0.08

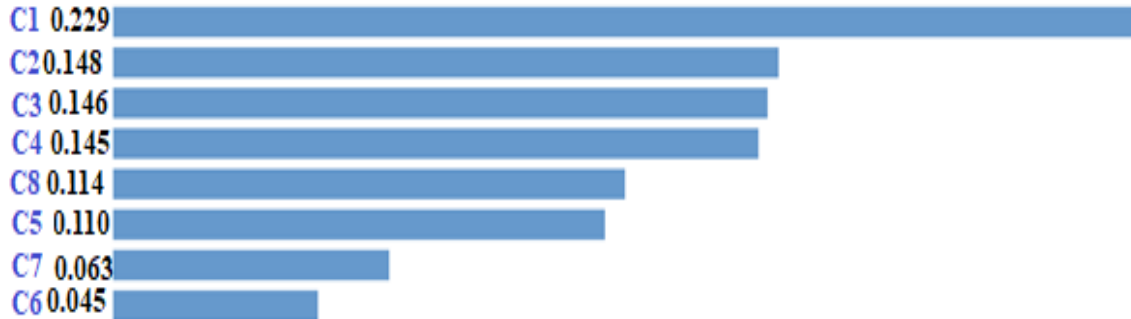


Figure 5: Diagram of Weighting and Prioritization of Criterion C's Sub-Criteria

In Figure 6, the diagram of weighting and prioritization of 19 sub-criteria are compared and the inconsistency is 0.07. The importance of the sub-criteria is as the following order:

1. Increasing the quality of products.
2. Increasing competitive advantage in the market.
3. Gaining credit in the market.
4. Meeting customer needs.
5. Using up-to-date knowledge in products.
6. Producing new products.

7. Increasing market share.
8. Reducing the cost of finished products.
9. Reasonable price of products in the market.
10. Modifying previous products.
11. Increasing efficiency.
12. Changing product formulation.
13. Reducing production time.
14. Reducing the amount of waste.
15. Reducing device failure.
16. Reducing production costs.
17. Reducing possible risks during work.
18. Simplifying the production process.
19. Changing production technology

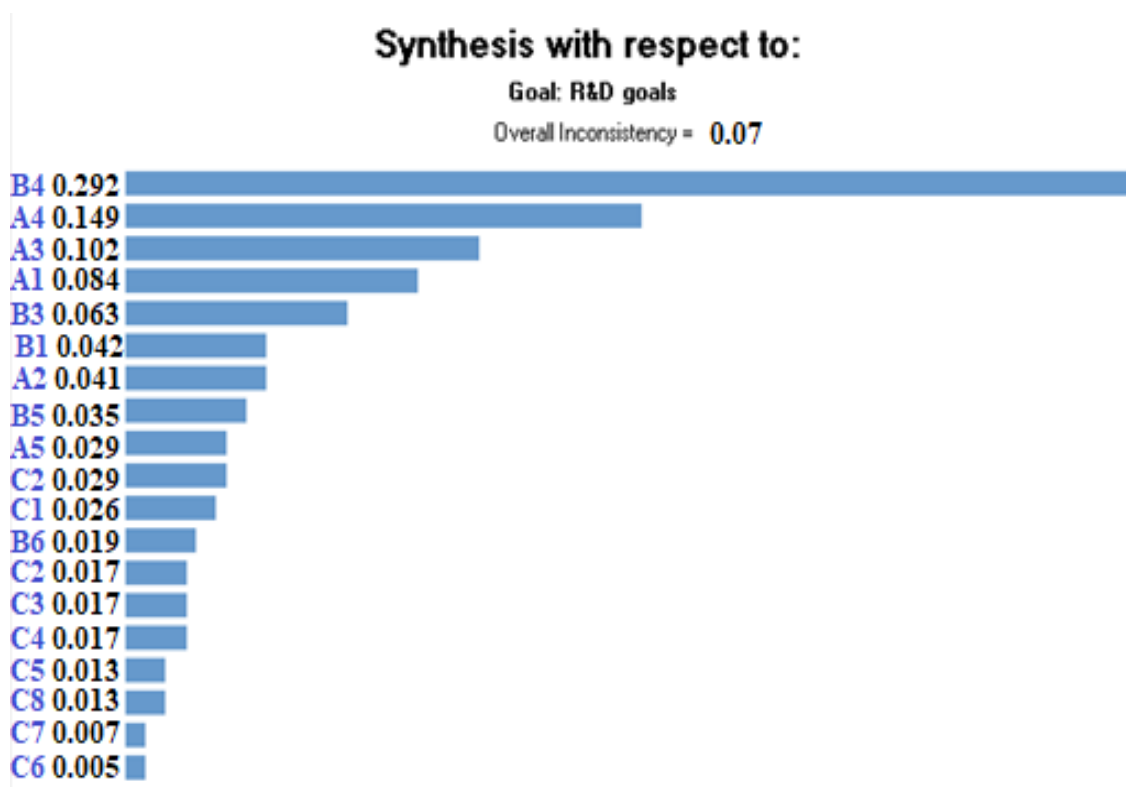


Figure 6: Diagram of Weighting and Prioritization of Total Sub-Criteria

5. CONCLUSION

In this research, the objectives of the research and development unit of Tabarestan Plastic Complex Company were examined at three main levels under the criteria of "market", "products" and "production". For the "market" criterion, 5 sub-criteria, for the "products" criterion, 6 sub-criteria and for the "production" criterion, 8 sub-criteria were defined according to the opinion of managers and experts of each department. After determining the criteria and sub-criteria of the research, questionnaires were designed for their pairwise comparison and given to managers and experts of each unit and they were asked to use the numbers 1 to 9 for scoring.

The data from the questionnaires were analyzed by Expert Choice version 11 software and the amount of weight and prioritization for the second level, sub-criteria of criterion A, sub-criteria of criterion B, sub-criteria of criterion C and total sub-criteria were measured. According to the output of the software in the second level, product criteria, in the sub-criteria, increasing the competitive score in the market, increasing the product quality and increasing the efficiency are the most important in the sub-criteria of criteria A, B and C respectively.

In all the sub-criteria, the sub-criterion of increasing competitive points in the market from the product criterion has the most importance and the sub-criterion of change in production technology from the production sub-criterion has the least importance.

The results of this research, while developing theoretical concepts related to the goals of the research and development unit of Tabarestan Plastic Complex Company, help the managers to have a more accurate assessment of the priority of the goals of this unit using the identified criteria.

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