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PROPULSIONS AFFECTING SUCCESS FOR NEW PRODUCT DEVELOPMENT IN KNOWLEDGE-INTENSIVE COMPANIES

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ABSTRACT

Knowledge-intensive companies have emerged to transform new ideas and innovations into products, commercialize research, integrate science and wealth, and empower and guide the graduates to work in the business environment. These businesses play an important role in the economic success of countries in terms of creating sustainable technology-based jobs and seizing new opportunities. Therefore, identifying and investigating the factors affecting the growth and development of new product in such companies can be useful in planning and policy making to promote economic activity. The present study aimed at investigating the driving forces (drivers) affecting success for new product development in knowledge-intensive companies. This is an applied research and the statistical population included managers and entrepreneurs of Knowledge-intensive companies located in Science and Technology Park and business incubator of Sistan and Baluchestan University. A total of 14 diving forces and 3 factors were identified as the result of reviewing the literature and holding in-depth interviews with experts in the university and and to rank them by using the fuzzy analytic hierarchy process. The result showed that the technological driver is the most effective and customer involvement driver is the least effective factor on the success for new product development in knowledge-intensive companies.

Keywords: *new product development (NPD), new product, knowledge-intensive companies, science and technology park (STP)*

INTRODUCTION

Science and technology parks (STPs) and business incubator of technological centers support creative people with innovative ideas through creating conditions necessary for the growth and development of Knowledge-intensive companies and start-ups, as well as reducing their risk through supporting the infrastructures (Davis, 2009). In many industries, new product development and commercialization have been regarded as the sustained competitive advantages of the businesses. Meanwhile, the development and growth of the companies is associated with their ability to develop the new products (Dogherty and Hardy, 1996). Science and Technology Parks develop technology and support Knowledge-intensive companies through creating technical knowledge and training specialized human resources. The success of these parks in many countries has played a major role in their scientific and economic development (Mahdavi et al., 2008). Knowledge-based businesses significantly affect production, crystallization of knowledge in new products and services, promotion of economic level and prosperity, and production of wealth and value-added in a society (Shankar et al.,

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2003). Basically, any movements toward innovation and any changes in the composition of products and services lie within the domain of knowledge-based companies (Sveiby, 2001). In fact, knowledge-based businesses work based on the dissemination, sharing and using information and knowledge (Clark, 2001). The abovementioned businesses, more than any other company, keep pace with emerging changes in the business environment and strive to survive in competitive environments (Desouza and Awazu, 2006). Clarke argues that the more the knowledge-based companies use the knowledge in their structures, the higher the value added and the more evolved cycle of growth are resulted (Golabi, et al., 2006). Considering the activities of small knowledge-based enterprises in different countries illustrates a close and effective association between social progress and the development of the enterprises.

Knowledge- intensive institutes are usually created in order to transform new ideas and innovations into products and create sustained technology-based jobs, commercialize research, and empower and guide the graduates into the business environment (Motemeni et al., 2012). Currently, marketing issues necessitate seeking some ways to produce more qualified products with the lowest cost in the shortest possible time due to the increase in competition along with the changes in the business environment (Zhao, et al., 2014). This issue encompasses New Product Development (NPD) projects because of the importance of such projects for the survival and success of many companies through providing newly developed products to the market (Lin and Chen, 2004). Identifying the factors contributing to the success of a new product is an important managerial concern, as the success of new products is not only a major source to improve financial and market performance, but it may also lead the company to grasp the business opportunities. Some factors that may jeopardize new product development include R&D (research & development) costs rising, rapid and fundamental technology growth, short product life cycles, increased competition and high failure rates for the new products (McNally, et al., 2011). On the other hand, the question that is mostly raised is how to eliminate the factors leading to failure of a new prduct while this problem has been examined by various researchers and scholars of this field of study.

The next section makes a review of the literature and the background of the study related to new product development and the drivers affecting the success of a new product development. The third section takes the fuzzy hierarchical analysis and its steps into account, the fourth section analyzes the data, and the final section makes a conclusion regarding the results of the study.

LITERATURE REVIEW

In the business world, there has been a rise in the demand for knowledge in addition to human resources and physical assets, since knowledge is one of the most important factors leading to the economic growth. Knowledge is transformed into products and services that form the basis of the economic development in a country. Knowledge is the most important factor of innovation and it is essential to disseminate the knowledge to all production processes in the enterprises (Shafi'zadeh and Mohseni, 2012). Science and technology parks and business incubator of technological centers are kinds of infrastructures built to support Knowledge-intensive companies. Castell and Hall (1994) listed three motivation for establishing science and technology parks; reindustrialization, regional development, and synergy creation. According to Story and Tether (1998), the role of science parks is to empower companies in

local universities in order to commercialize research ideas and to create the basis for business activities that utilize sophisticated technologies.

The most important environmental forces that have a direct impact on the performance of manufacturing organizations are the competitive forces that govern the environment of the organization. The development and production of new products is a process that has always been a competitive advantage for the manufacturing organizations. In fact, differentiation through new product development is one of the most effective ways to success of NPD (Wang, 2009). The new product development process encompasses all activities that take place when developing and establishing new products in a company (Bhuiyan, 2011).

An example of a general classification of new product definitions has been provided by the Bose Allen & Hamilton Consulting Center (OECD, 2013); "By new product, we mean original products, product improvements, product modification and new brands that the firm develops through its own research and development efforts". In the light of above definition, a new product will be considered anything which is perceived as such by the consumer or with which the firm has no previous experience. It means that a consumer views a product as new if any new thing is experienced or any additional variants are provided with the existing product.

Many researchers, including Cooper (1999) and Wind (1982) attempted to develop a model that incorporates the steps involved in the new product development process. Given the variety of perspectives on new product development models and their steps, Table 1 briefly lists the different models.

Table 1. Different models of the new product development process (Kanaani and Maigon Pour, 2014)

Researcher	Process steps
Koltre (2003)	Idea Generation, Idea Screening, Concept Development and Testing, Marketing Strategy Development, Business Analysis, Product Development, Test Marketing, Commercialisation
Cooper (1999)	Scoping, Build business case, Development, Testing and validation, Launch
Marion and Simpson(2009)	Ideas / Creativity, Initial Evaluation, Innovation Project, Sample Design and Test, Product Testing & Validation, Mass Production, Market Launch
Bigliardi et.al (2010)	1- Identification of the market need and generation of the "idea" of the product, 2 - Development of the technological solution 3 - Pre-testing of the product with selected customers, 4.Product development and launch in the market 5. Expanding it to different markets

Essential success factors can be defined as areas in which the results in those areas, if satisfied, will ensure successful competitive performance for the organization. Rockhart (1979) identifies the key success factors as the limited number of areas in which results, if they are satisfactory will ensure successful competitive performance for the organization. They are few key areas where things must go right for the business to flourish. If results in these areas are not adequate, the organization's effort for the period will be less than the desired. Various studies have been conducted on the key factors behind the success of new product

development. Brown and Eisenhardt (1995) consider research on the success or failure factors of new product development projects into three factors: plan, communication web, and disciplined problem solving.

Poulton and Barclay (1998) have categorized success factors into two major strategic and tactical factors. On the other hand, Howard and Osimansky (2001) point out the importance of corporate strategy and the characteristics of development processes as being highly relevant to this general context. They have also described market characteristics as environmental situations that must be evaluated and adapted to the company's strategies.

Key success factors of a new product development project include a structured process of new product development (such as a clear strategy, strategies and operational plans), specific goals, product definition, long-term vision (having a plan for the future), strong and capable leaders, understanding and being familiar with the market, support of senior management, the customer involvement in the process and care about the customer. On the other hand, it is very important for the development researchers to emphasize the success of new product development. The product development team should have a clear, shared vision (Lynn, et al., 1999). How the group is formed and how it is composed and whether the members of the group need to have the necessary skills, experience and motivation, as well as the need for the group to have a good relationship with senior management and flexibility for potential changes by the group and its reflection on the product and its features are very important factors which need to be taken into account (Cooper, 1999).

In a study by Kandemir and Rosana (2006), the key success factors have been divided into human resources, development resources, evaluation resources, and startup resources. Their findings indicate that the most important factors for product success include product advantages, product definition, and pre-development expertise, technological synergies and marketing. The first driver affects the three factors of customer satisfaction with current product, product attractiveness for current customers, and product attractiveness for larger customer groups.

Young (2011) considered the factors influencing the success of new product development in applying project strategy in four types including techniques, costs, operations and qualities. Bigliardi et al. (2010) consider the factors influencing the success of a new product development as; i. Differentiation, ii. Voice of the customer, iii. Market launch, iv Innovation protection mechanisms, v. Reduced time to market.

Suwannaporn and Speece (2010) examined Thai food processing industry and they found that the use of marketing research during the NPD process seems to be the most important factor leading to higher success rates.However, internal information flow and communication is also an important determinant. Likewise, supplier linkages show an impact, though perhaps slightly less than that of information flow and communications. New product strategy and planning play a role too, although it seems to be a somewhat weaker contributor to success rates, according to our data. Managers tend to view strategy and planning elements to be the most important success factors. They rank marketing issues – including marketing research, and communications and information flow issues – as relatively less important. However, manager perceptions of importance of these success factors are not able to distinguish low from high success rates, while reported practice can distinguish them. One important reason for this is probably that managers in different functions each have their own view of NPD, and

cannot agree on what is important. Thus, aggregate measures of importance have little predictive ability.

Fritz and Schiefer (2008) examined sustainability models which requires that the long-term development paths have to balance the improvements in monetary benefit–cost balance and the society's consideration of the benefit–cost balance to assure acceptance and sustainability. They underline the importance of large-scale supplying of sustainable products, linked to the markets and transaction-costs.

Mu et al. (2007) divided the success factors as technological, marketing, managerial, and commercializing factors. Sun and Wing (2005) consider the success factors of new product development in defining the target market clearly, applying quality standards, having clear project objectives, making internal communication with the project team, delivering the product on time, caring about customers, launching timely , considering competitive cost of the product. Cooper (1999) identified the eight successful NPD factors as follow; up-front homework before proceeding further from the idea stage; building in the voice of the customer; seeking differentiated and superior products; early and stable product definition before actual development; strong market launch; tough go/kill decision points; organizing around cross-functional project teams; building an international orientation into the NPD process.

Poulton and Barclay (1998) identified the factors influencing the success of a new product development in supporting senior management for innovation, accepting senior management risk, supporting an entrepreneurial culture, having a long-term strategy with an innovative focus. However, Lester (1998) regarded these factors correlated with the commitment of senior managers, vision, strategy, and support.

RESEARCH METHOD

The current study is a survey and an applied research since the obtained results are applicable to other sectors active in this field. Besides, this is a causal research in term of value due to the purpose of the study which is to investigate the impact of the effective drivers on the success of the new product development. Meanwhile, it is a survey since it identified and determined the impact of the effective drivers on the success of the new product development through the data which were gathered in the field and analyzed. This study seeked to identify and rank the factors that influence the success of new product development. The research was conducted in two phases. In the first phase, the factors affecting the success of the new product development have been identified by using library documents and resources and holding interviews with experts and managers of Knowledge-intensive companies. In the second phase, the identified factors have been ranked through using questionnaires and fuzzy analytic hierarchy process.

Since the purpose of this study was to prioritize the drivers affecting the success of the new product development, a multi-criteria decision making method which is a hierarchical analysis was used. The hierarchical analysis process is a multiple criteria decision making method which enables the formulation of the problem in a hierarchical way, as well as the possibility of considering different quantitative and qualitative criteria in the problem. In addition, this method is based on pairwise comparisons that facilitate judgment and calculations. Another advantage of the hierarchical analysis process is that it provides the structure and framework for collaboration and decision-making. Once the hierarchy is built, the decision makers

systematically evaluate its various elements by comparing them to each other at a time, with respect to their impact on an element above them in the hierarchy. In making the comparisons, the decision makers can use concrete data about the elements, but they typically use their judgments about the elements' relative meaning and importance. It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations. The first level represents the purpose of the decision and the last level represents the items that are compared. Intermediate levels also represent factors that are considered as criteria for comparing items.

Conceptual Model

Regarding the previous studies and the expert views, three drivers of new product development success, namely; high product sales, customer satisfaction, reduced time to develop product were selected and fourteen drivers affecting the new product development success were selected based on the available resources. All fourteen drivers were critical to success. The importance and impact of each driver has been identified and ranked with by using Expert Choice software.

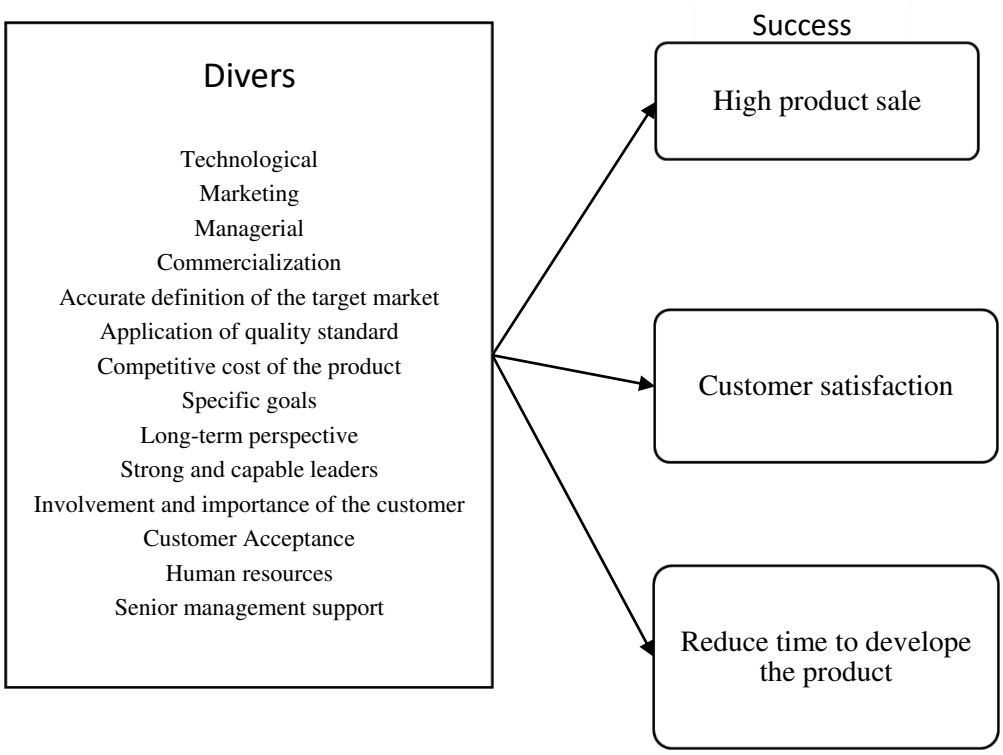

Figure 1. Conceptual model of the study

Statistical population and sampling

The statistical population of this study is qualitatively divided into two groups. The first group included some people with academic experiences in the new product development and the second group included some people who have job experiences in this field (development of at

least 3 new products in an industrial section). Quantitatively, the statistical population of the study included some experts and senior executives of Knowledge-intensive companies in the fields of biotechnology, advanced manufacturing equipment and laboratory production, oil and gas and petrochemicals, information and communication technology and computer software, electrical and electronic and computer hardware, advanced materials, advanced medicine and medical engineering. Due to having an access to just a known and limited population, the census method was used. A survey that measures the entire target population is called a census. A sample refers to a group or section of a population from which information is to be obtained. In the census, the total number of members of a population was studied individually. A census of finite population is a type of survey that covers all units of the population. Ten questionnaires were sent to ten experts out of which five questionnaires were received and finally, five questionnaires were investigated.

Data Collection Instrument

To collect the data, questionnaires were used to obtain the experts' opinions through a paired comparison matrix. The questionnaires were designed to allow the respondents to compare the criteria and sub-criteria and the significance of each. To assess the validity of the questionnaire, the opinions of the experts working in Science and Technology Park and some university professors' views were investigated. Also, to assess the reliability of the questionnaire, the incompatibility rate (which should be higher than 0.1) was used. After collecting the experts' answers in the form of verbal phrases, the answers were converted to a fuzzy scale. The scale used in this study is the 9-point fuzzy scale (2) which was proposed by Kaul and Verma (2011) based on 9-point Saati scale.

Table 2. Fuzzy value and corresponding verbal phrases

Symbol	Fuzzy value	Preferences
U	(0,0,0.1)	Unimportant
LI	(0,0.3,0.5)	Low important
FLI	(0.1,0.3,0.5)	Fairly low important
N	(0.3,0.5,0.7)	Normal
FI	(0.5,0.7,0.9)	Fairly important
I	(0.7,0.9,1)	Important
VI	(0.9,1,1)	Very important

Fuzzy hierarchical model

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology developed by Saaty in the 1970s. The basis of this method is based on pairwise comparisons. The FAHP (fuzzy analytic hierarchy process) is performed by using classical AHP fuzzy numbers and Fuzzy calculations (Azar and Faraji, 2010). To deal with ambiguity of human views, Zadeh (1965) proposed fuzzy set theory to model uncertainty caused by ambiguity and inaccuracy in events.

Chang (1992) presented a very simple method to extend the hierarchical analysis process to fuzzy space, based on the arithmetic mean of expert opinions and the Saati's normalization

method by using developed fuzzy triangular numbers (Zanjirchi, 2011). This method is done as follows:

Step 1: Drawing a hierarchical Tree: In this step, the hierarchical structure of the decision is first drawn by using objective levels, criteria, and items.

Step 2: Making Paired Comparisons Matrix: At this stage, the concordant matrices are formulated according to the decision tree using expert opinions, and then the incompatibility rates are calculated according to the Gogus and Butcher (1998) method;

Step 3: Making Defuzzified final fuzzy pair wise comparison matrix. Defuzzification of the fuzzy numbers is performed by the following equation:

$$x_{ij} = \frac{\left[\left(Ux_{ij} - Lx_{ij}\right) + \left(Mx_{ij} - Lx_{ij}\right)\right]}{3} + Lx_{ij}$$

Where Ux_{ij} is upper limit, Lx_{ij} is lower limit, Mx_{ij} is the medium limit.

Step 4: Calculating the arithmetic mean of comments

Step 5: Calculating the sum of the row elements

Step 6: Normalizing the weights of the rows

Step 7: Calculating the degree of probability of being larger

Step 8: Normalizing the weights vector

Step 9: Combining weights to achieve priorities (Zanjirchi, 2011)

ANALYSIS OF THE RESULTS

Using the hierarchical structure (Fig. 1) and following the steps of the fuzzy hierarchical analysis process, first the experts' opinions (by converting the verbal phrases into fuzzy triangular numbers according to the table (2) were collected and to ensure the rate matrix compatibility, the incompatibility rate was calculated according to Gogus and Butcher (1998) method. Then, the weight of each criterion was calculated at the levels of two and three hierarchical structures. After reviewing the literature of the study, a three-level hierarchy was used. At the first level, the target which is the drivers effecting new product development have been investigated. Regarding the previous studies and the experts' views; in the second level, some criteria were selected and in the last level the chosen items have been compared. After reviewing the available sources, 14 items were chosen among the most frequently used factors in the literature of the study as the final model items, and finally a hierarchical tree was drawn as follows:

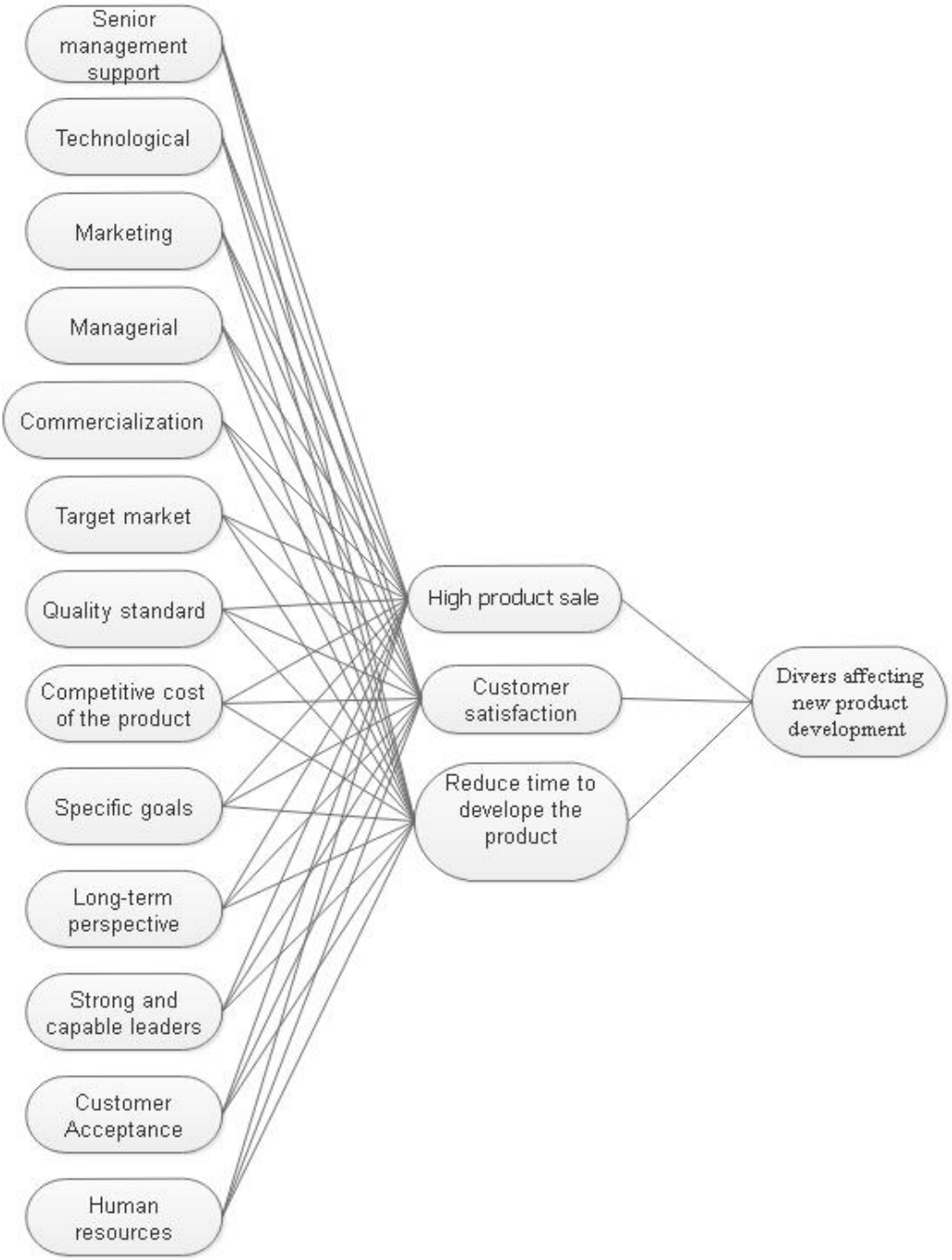

Figure 2. A hierarchical tree of driver s affecting new product development

The final weight of items and criteria were calculated based on the following table by using Expert Choice software and finally the final weights of the items were calculated and prioritized according to their respective criteria by summing items in their respective criteria.

Table 3. Relative and final weights of criteria and sub-criteria

Criterion	Criterion Weight	Items	Weight of items
High product sale	0.345	Technological	0.082
		Marketing	0.078
		Managerial	0.078
		Commercialization	0.075
		Accurate definition of the target market	0.074
		Quality standard	0.073
		Specific goals	0.073
		Strong and capable leaders	0.071
		Senior management support	0.068
		human resources	0.067
		Competitive cost of the product	0.066
		Long term perspective	0.067
		Customer Acceptance	0.066
		Customer involvement	0.065
Reduced time to develop the product	0.332	Technological	0.086
		Marketing	0.081
		Managerial	0.079
		Commercialization	0.079
		Accurate definition of the target market	0.072
		Quality standard	0.067
		Specific goals	0.074
		Strong and capable leaders	0.071
		Senior management support	0.069
		human resources	0.069
		Competitive cost of the product	0.062
		Long term perspective	0.067
		Customer Acceptance	0.069
		Customer involvement	0.055
Customer satisfaction	0.323	Technological	0.081
		Marketing	0.079
		Managerial	0.081
		Commercialization	0.072

		Accurate definition of the target market	0.077
		Quality standard	0.075
		Specific goals	0.072
		Strong and capable leaders	0.069
		Senior management support	0.068
		human resources	0.066
		Competitive cost of the product	0.067
		Long term perspective	0.063
		Customer Acceptance	0.059
		Customer involvement	0.069

Considering the final weights of criteria and items (Table 3), it is possible to prioritize the drivers affecting the new product development. Figure 3 shows the final weights of the criteria. According to Figure 3, considering the criteria, high product sale was scored 0.345 which shows the highest impact on new product development, following by the reduced time to develop the product which was scored 0.332, and finally customer satisfaction which was scored 0.323.

Figure 4 shows the bar chart of the items weights. Regarding the obtained values of the items criteria, technological (0.0815), marketing (0.0781), and managerial drivers (0.0774) showed the highest impact on the new product development. Besides, the drivers of competitive cost of the product (0.0659), customer acceptance (0.0657) and customer involvement (0.0642) showed the lowest impact on the new product development.

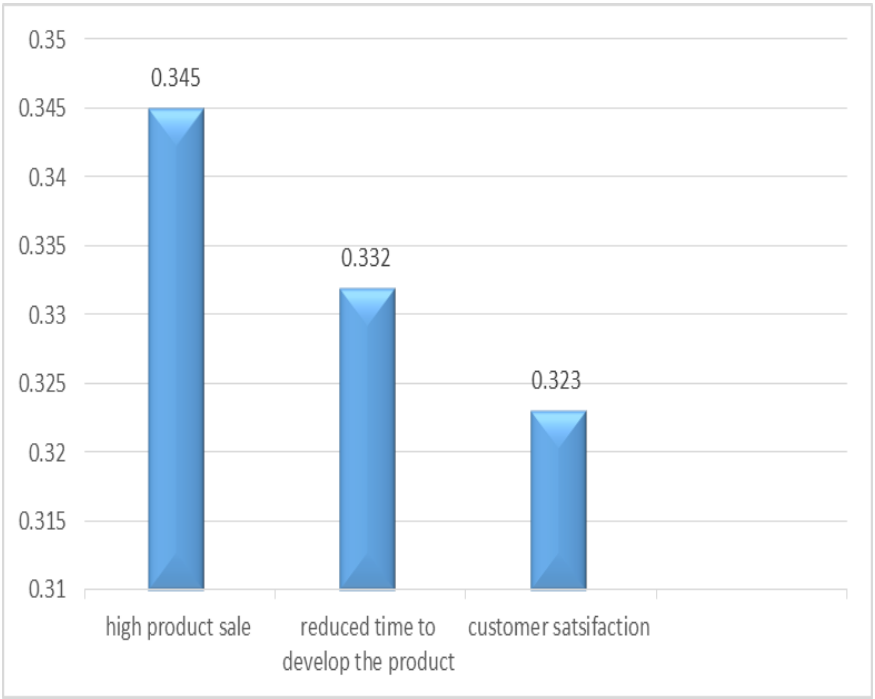

Figure 3. Final weights of criteria

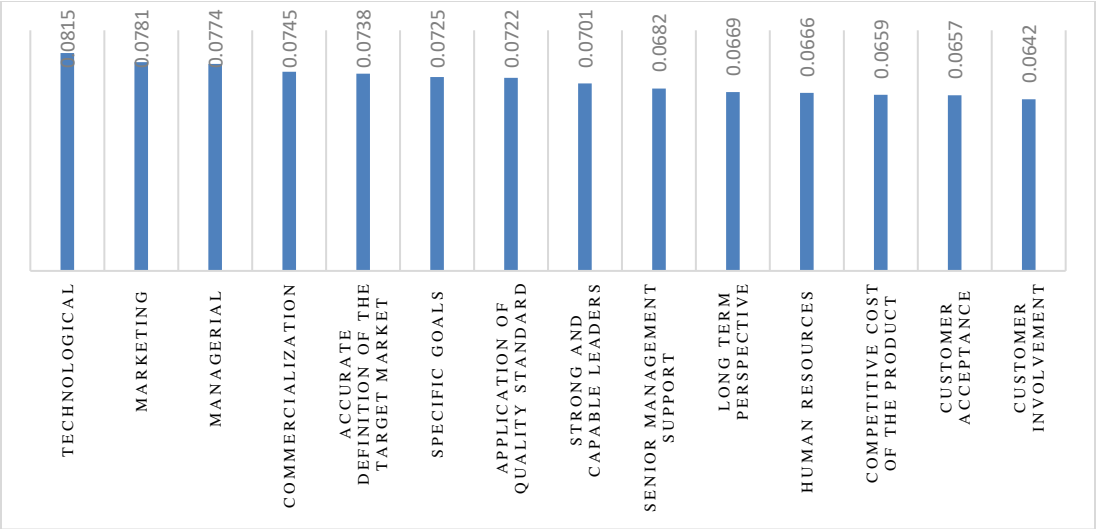

Figure 4. Final weights of items

DISCUSSION AND CONCLUSIONS

Currently, the process of new product development has been regarded as a competitive advantage for different manufacturing and service organizations. It is necessary to find out what percentage of each organization has been devoted to R&D activities for the new product development in order to surpass the competitors. It emphasizes on the current and strategic position of the organizations in the demanding market. The present study examined the drivers affecting the success of the new product development in the Knowledge-intensive companies. The results of the study indicated that several drivers affect new product development, such as high product sales, reduced time to develop the product, customer satisfaction, an accurate definition for the target market, quality standard, Competitive cost of the product, specific goals, long-term perspective, strong and capable leaders, customer involvement, customer acceptance, human resources and senior management support. Research findings showed that regarding the experts' views; high product is the most significant driver affecting the new product development and also the emerging technology plays a vital role in the success of the product as well. However, the high product sale priority does not diminish the importance of the other drivers, and all are important and significant as well. In this regard, all three mentioned drivers need to be taken into account during the process and various steps of the new product development. Many other studies have been conducted in other countries, and the main innovation of this paper is the study of some new drivers with defined components whose impact on the new product development has been investigated. To make it short, the drivers affecting the new product development have been ranked according to the amount of impact while the technological driver was found to be the most affective driver. The other affective drivers are marketing, managerial, commercialization, accurate target market definition, specific goals, quality standard, strong and capable leaders, senior management support, long-term vision, human resources, cost competitiveness and customer acceptance factors; respectively. Finally, customer involvement has been scored as the least important

driver. Therefore, due to the wide statistical population of this study, it is possible to generalize the results of this study to the new product development in other cities and industrial centers.

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