A new systematic approach in new product development through an integration of general morphological analysis and IPA

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C H R O N I C L E	A B S T R A C T
	New product development is a modern approach to deal with the environmental changes and an introduction to enter the competitive atmosphere is a challenging condition. By realizing the critical aspects of success of the new product and selecting a compatible model of variables in these aspects, companies may create a unique context for developing the product; but whether in terms of the multiplicity of the decision-making choices or the inherent conflicts of the response atmosphere's variables, the complexities of the current world have caused disruption and inefficiency in the field of optimal selection and decision making. The aim of this study is to identify the critical aspects of development of the new product in the Sedan automobile class and to offer a morphological model of that by investigating the ideas and comments of the experts and scholars. In this regard, by using the Importance-Performance Analysis (IPA) method, the proposed method assesses the mode of the organization; and with the General Morphological Analysis, it assesses and searches for the most compatible decision-making variables to find the fully optimal and compatible solutions. After studying the subject literature, seven critical aspects are selected for the product development and three purposes are chosen for limiting the morphological model. Finally, four fully compatible configurations and one configuration are proposed with the entrance of the aspects determined from the output of IPA method. The innovative solution in solving the morphological model and its integration with IPA method are considered as the innovations of this study.

1. Introduction

Most pioneer companies all over the world are completely aware of the fact that the most important factor causing their success and preferences in the global competition market is to have the ability to continue designing the new products for the market faster and most effective than the other competitors. Development of new product and improvement of the current product play essential role for most

successful producers. New product development is a very important process to guarantee the company's survival because of the welfare and the development of the national economy of the countries. Multiple aspects of the issues in the current era create useless and destructive conflicts in the new product development process. As a result, all producer seek for the development of patterns and methods, which help them minimize the failure risks of such projects and increase diversity in products.

Development and introduction of a new product is from the most important strategic decisions, which can be made (Cooper, 1999). However, achieving the development of new successful products is not easy and a few percent of the new products brands are successful (Marzler & Hinterhuber, 1998). Today, there is a worldwide competition among different companies in terms of new product development. This competition is based on tens of thousands of business activities and includes a wide range of activities such as market research, product development, production process and the products services. Regarding to the high cost of these projects for their organizations, when developing new products, a deep understanding of the needs and expectations of the customers, techniques, and the knowledge of developing new products is required to achieve the business purposes (Lagrosen, 2005).

From the strategic viewpoint, the new product development process must positively answer the customers' expectations and create an appropriate competitive field for the organizations by relying on the preference of technology and suitable allocated budget (Smith et al., 2004). If we plan to reach a comprehensive perception about the new product development process, we have to do it in its best way. However, what is clear is that the process of new product development has a multi-aspect nature that should be identified and modeled in order to propose its desired system.

Basically, administrating a prescription for all companies is not possible, because the nature of companies, their strategies, and the most importantly, the types of products and goods are the factors, which increase the complexity of the issues. The general pattern of new product development is from the creation of idea to delivering it to the customer. This general pattern passes different stages during the new product development and they are sometimes in the form of filter or feeding lines and in fact bring the products to the evolution stage; hence, the process of new product development includes all processes related to strategy, organizing, concept creation, creating and assessing the product, creating and assessing the marketing and commercialization plan of a new product (Chen, 2012).

This study is intended to propose an integrated model in automobile industry in order for us to have a successful new product development process.

2. Literature Review

Here we investigate the literature of the new product and the critical aspects in success. In 1990, Copper compared the successful and unsuccessful companies in production and product development through regular studies and investigated the factors influencing the acceleration of the new product's success during 20 years for 100 durable products in 35 companies in Europe and the Northern America and the chemicals' producers. He showed that the marketing factors (customer need, production time, profit, market share, economic effect on the customer, and creating value for the customer), technology (technology's success, technology's value, and reduction of cost) and the commercializing factor with indices of the company specification, competitiveness of the product, and the efficiency of the product management team had been respectively from the important indices in NPD process in the companies. Sarmad Saeidi and Mamqani (2009) studied the key factors of success in new product development in Saipa Automotive Group through the hierarchical analysis approach. They investigated factors such as team, motivation, idea screening, and monitoring competitors, knowledge, decision-making risk in management, using consultants out of the company, the staffs' and the project team's competency, motivation, commercialization, etc. They examined four technologic, marketing, new product team, and commercialization.

Yoon and Park (2005) carried out a factor analysis for factors influencing on technology, research, and development and finding solutions using the morphologic analysis. They reported that through using the morphologic analysis, it is possible to reduce the number and filtering the technological options.

By investigating the critical factors in new product development from the viewpoints of industry managers in 74 Chinese industrial companies, Mu et al. (2007) showed that four technological, marketing, managerial, and commercializing factors were critical and significant for the new product decision-making in all industries in the successful decision-making for producing new product. In 2008, they also investigated the impact of the risk management strategy on the performance of new product which was the result of examining 217 manufacturing companies in China. They showed that the risks existed in technological, marketing, and managerial risks and the integration of three factors with each other maintained a positive impact on the performance of the new product development.

With the paper of systematic approach for developing a new business model in a telecommunication company and using the morphologic analysis and fuzzy integrated approach, Im and Cho (2013) quantified the output of the morphologic analysis. Their two-step proposed method included the identification of a set of all possible combinations of business model with morphological analysis; and in the second step of assessment, it included ranking and selecting by means of the Fuzzy Analytical Hierarchy Process (FAHP) and TOPSIS solution.

3. Soft Research Methodology

Soft operational research includes a set of methods and methodologies that based on the different perceptions of the benefactors, adjust the required structure for the bad-defined, chaotic, and unstructured problems. In other words, it can be said that soft operations research is the methodology set of "problem structuring methods (PSM)". From these methods, we can refer to the soft systems methodology, cognitive mapping, analysis and development of strategic options, strategic option approach, stability analysis and structural and perceptional modeling (Azar et al., 2013), and morphology (Ritchey, 2011). In this multiple paradigm, there are multiple methodologies like network analysis, DEMATEL, and importance-performance analysis methodologies (Azar et al., 2013).

3.1. IPA Method

Importance-performance analysis was first introduced by Martila and James (1977) for analyzing the performance of car industry. This approach provides an insight for the managers to identify the strength and weakness of the organization. IPA simultaneously identifies the most important influencing factors on the customer's satisfaction as well as the low performance features of the organization that should be immediately improved and contributes to the managers to provide better services (Azar et al., 2013). The traditional approach is structured to the importance-performance by the two-dimensional matrix. This matrix consists of two axes where X-axes shows the performance and Y-axes indicates the importance. As it is shown in the Fig. 1, this matrix is divided into four quadrants.
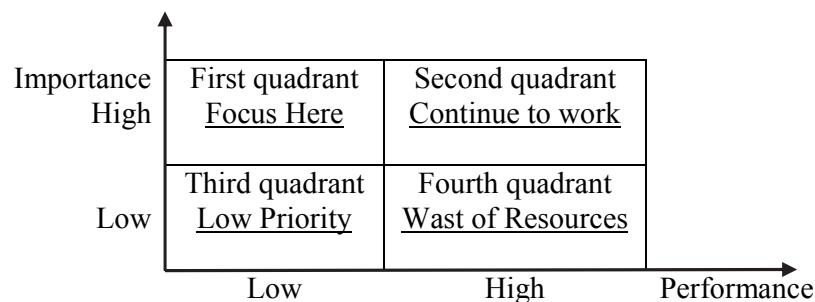

Fig. 1. importance-performance matrix (Azar et al., 2013)

1. The first quadrant (focus here): the perceived features are very important for the respondents, but the performance level is relatively low. This quadrant shows the fundamental weakness of the organization; hence, it requires immediate attention for being improved.

2. The second quadrant (continue the work, well): the perceived features are very important for the respondents, meanwhile, the performance of the company in these activities is at its highest level; hence, under this condition, the work should be well maintained and kept on.

3. The third quadrant (low priority): the perceived feature in this quadrant is assessed low in terms of performance and importance. However, here the performance level is low, but the managers should not pay so much attention to this part.

4. The fourth quadrant (waste of resources): this quadrant includes features with low importance but relatively high performance; in other words, the resources allocated to these features are more than the required values.

To do the importance-performance analysis, the following steps should be done:

The first step: identify and extract the features and aspects. This may be done by studying the subject literatures and by surveying of the experts and customers.

The second step: determine the importance degree of the aspects and the performance degree of the qualitative features of the aspects. b_{jp} and c_{jp} respectively represent the importance value and performance value determined for the aspect j and by the decision-maker or expert p. This value is determined by using 5 or 7 options Likert scale.

The third step: use the geometric mean and integrate all comments of the experts. Here b_j is the final value of the importance and c_j is the final value of the performance of the aspect j that is the result of the cumulative comment of p experts.

$$c_j = \left(\prod_{i=1}^{n} c_{jp}\right)^{1/n} \tag{1}$$

$$b_j = \left(\prod_{i=1}^{n} b_{jp}\right)^{1/n} \tag{2}$$

Therefore, each qualitative aspect (j) has an importance degree and a performance degree.

The fourth step: calculate the threshold value. The threshold value is used for determining the IPA matrix cells. The arithmetic mean is used to determine the threshold value. The threshold importance value and the threshold performance value are respectively shown with μ_b and μ_c, respectively.

$$\mu_b = \frac{\sum_{j=1}^{m} b_j}{m}, \tag{3}$$

$$\mu_c = \frac{\sum_{j=1}^{m} c_j}{m}. \tag{4}$$

The fifth step: determine the relative location of each of the qualitative features of services on IPA matrix.

The sixth step: The gap between the importance value and performance vale of the feature j multiplied by its importance value can show the weight of the qualitative aspect. The weight of the j feature is shown by OW_j.

$$OW_j = \left|(b_j - c_j) \times b_j\right| \tag{5}$$

For more ease in analyzing, we normalize that as following:

$$sw_j = \frac{ow_j}{\sum_{j=1}^{m} ow_j} 1, \quad \sum_{j=1}^{m} sw_j = 1. \tag{6}$$

The aspects with higher sw_j should be located in higher priority to be paid attention to.

3.2 General Morphological Analysis Method

Morphology originates in the Greek word Morph, which means the study of shapes and forms. The morphology analysis concentrates on the structure and combination of a part of the subject and how they are combined to create a concentrated whole.

The asked subject may be a physical or social. We may name typology as one of the simplest discussions of morphology that is based on the possible combinations between the two variables; so that each of the variables includes two values or modes. In the typology, each possible combination of value-variable is called a structure. The simplest and yet the most common type of typology is a four part table that has two variables against each other (Ritchey, 2011).

The morphological analysis steps are as follows, (Ritchey, 1998):

1. Determining the parameters and problem aspects: the morphology problem solving starts with identifying and determining the aspects of the problem that we want to investigate.

2. Determining different possible modes for each aspect or parameter: in this step, a range of values or different modes is allocated to each aspect or parameter.

3. Configuring the morphological context: by placing parameters against each other in a table, the n-dimensional morphological filed is formed. The number of morphological aspects depends on the number of parameters obtained from the problem. A combination includes a value or mode of each of the parameters and it proposes a solution for the multiple-dimensional complex problems. Each of the combinations is called a field configuration.

5. Cross-consistency assessment (CCA): the next step in morphology is to reduce and to eliminate the possible arrangements of configurations in the problem space to fewer numbers with internal consistency with each other. This set of arrangements with internal consistency is called "the answer space".

Cross-consistency assessment is based on the approach that many pairs of modes for different aspects may be in contradiction or conflict with each other. When two modes are in endless contradiction with each other, all configurations of these two modes are incompatible and should be removed.

To assess the cross efficiency, all modes in the morphological field in a pair comparison matrix are compared with each other and their compatibility and incompatibility and the value of this incompatibility is determined in pair form. Three types of compatibility are considered in the morphology including:

The blank, means that there is no conflict in the nature of the two investigated concepts;

X, experimental constraints (there are some limitations that we have experienced them among the concepts)

O, normative constraints (the enacted constraints caused by the moral, political, or other grounds)

Like the ISM method, aggregation of the experts' ideas will be based on mode of comments.

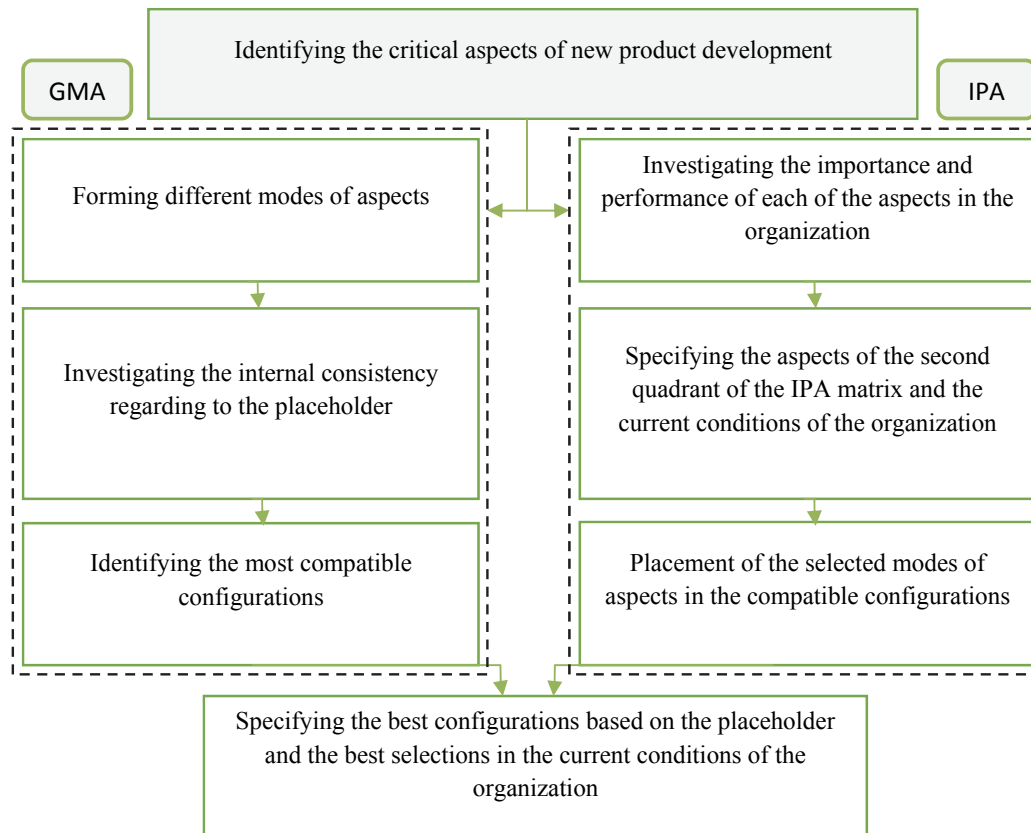In Fig. 2, the approach of the current study is summarily shown.

Fig. 2. The research approach

4. Calculation Results and Assessment

After providing the main framework and identifying the critical aspects of the success of the new product development from the review of the literature of this field, the seven aspects determined in the table have been considered for this study. In this part, using the interview and questionnaire tools and snowball sampling method and with theoretic saturation, the required information of the morphological field of this expert was gathered from the experts, scholars, and benefactors. The center of this study is Saipa Co., by having 42% of the domestic market share, which is considered as the second car producer of the country after Iran Khodro. Now, with having dozens of subsidiaries, this company is from the largest industrial manufacturers in Iran. In 1993, The Center of Research and Innovation of Saipa Automotive Industry was established with the direct investment of Iranian car manufacturing company Saipa and then, it was officially put into operation in 1997 with building the administrative, workshop, and library spaces as well as purchasing and installation of the required hardware and software equipment. Now, this company has the development of three platforms S100, S200, and S300 in its agenda.

After concluding the frequent debates, in the first step of morphological method, the critical aspects of success have been identified and they are summarily shown in the Table 1.

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Table 1
The critical aspects of success of new product development

Aspect	Reference
Project Management	Poolton & Barclay, 1998; Maidique & Zirger, 1999; Cooper & Kleinschmidt, 2007; Sarmad Saeid & Mamqani, 2009; Ardakani et al., 2011; Rajab Zade Qotri & Moezi, 2014; Rafiei Nezhad, 2014; Meygoun Pouri et al., 2014
System Management	Lester, 1998; Thompson, 2003; Seyed Hoseyni & Iranban, 2004; Ali Ahamdi et al., 2009; Ardakani et al., 2011; Talebi et al., 2011; Chen, 2012
Technological and Technical	Mu et al., 2007; Fritz & Schiefer, 2008; Ali Ahamdi et al., 2009; Ardakani et al., 2011; Talebi et al., 2011; Chen, 2012; Kan'ani & Meygoun Pouri, 2014
Commercialization	Cooper, 1990; Kandemir et al., 2006; Mu et al., 2007; Ali Ahamdi et al., 2009; Naranjo Valencia et al., 2010; Ardakani et al., 2011; Talebi et al., 2011; Kan'ani & Meygoun Pouri, 2014
Team Structure	Sharma, 2006; Tushman, 2007; Sarmad Saeid & Mamqani, 2009; Jafari Khanshir et al., 2012; Khasm Afkan et al., 2014
Culture	Abbey and Dickson, 1983; Cooper & Kleinschmidt, 2007; Naranjo Valencia et al., 2010; Ardakani et al., 2011; Rajab Zade Qotri & Moezi, 2014; Khasm Afkan et al., 2014
Human Resources	Seyed Hoseyni & Iranban, 2004; Jantunen, 2005; Kandemir et al., 2006; Khasm Afkan et al., 2014

4.1. Importance-Performance Analysis

The first step: after identifying the aspects, IPA questionnaire was prepared.

The second step: the questionnaire was provided to 14 experts and in the obtained data is observable in the Table 2 .

Table 2

The IPA questionnaires filled by the experts

Code	Aspect		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Expert 9	Expert 10	Expert 11	Expert 12	Expert 13	Expert 14
A	Project Management	importance	5	5	5	5	5	7	3	4	6	5	5	7	7	3
		performance	6	7	6	4	3	7	7	3	6	3	5	6	5	7
B	System Management	importance	4	6	3	4	4	6	6	4	3	6	4	4	3	4
		performance	2	3	1	4	1	5	3	3	1	4	2	5	3	1
C	Technological and Technical	importance	5	3	6	6	5	3	7	6	7	7	4	5	4	5
		performance	6	3	5	4	3	5	5	3	4	5	3	2	6	3
D	Commercialization	importance	3	4	7	4	5	7	6	3	7	5	6	4	3	4
		performance	5	4	3	5	4	4	4	4	4	4	4	7	7	6
E	Team Structure	importance	7	4	7	4	5	6	6	5	3	5	5	7	4	5
		performance	3	4	4	2	2	3	3	3	3	5	1	3	3	6
F	Culture	importance	5	6	3	3	4	1	2	3	2	3	5	4	4	2
		performance	2	6	5	3	5	1	1	4	2	3	2	4	1	3
G	Human Resources	importance	3	4	7	6	3	6	6	7	6	1	2	7	3	6
		performance	2	3	3	4	5	3	2	3	1	4	4	3	3	2

The third step: use the geometric mean and integrate all ideas of all experts. Here, b_j is the final value of importance and c_j is the final value of performance of the aspect j that is the result of the cumulative idea of 14 experts.

$$c_j = \left(\prod_{i=1}^{n} c_{jp} \right)^{1/n} \quad \text{and} \quad b_j = \left(\prod_{i=1}^{n} b_{jp} \right)^{1/n}$$

Table 3
The final values of importance and performance of the aspects

Code	Aspect	ci	bi
A	Project Management	5.115	4.981
B	System Management	2.318	4.223
C	Technological and Technical	3.880	5.032
D	Commercialization	4.511	4.638
E	Team Structure	2.972	5.070
F	Culture	2.560	3.057
G	Human Resources	2.805	4.224

The fourth step: calculate the threshold value with the arithmetic mean to determine the cells of IPA matrix.

$$\mu_b = \frac{31,224}{7} = 4,460$$

$$\mu_c = \frac{24,141}{7} = 3,451$$

The fifth step: the relative location of each of the qualitative aspects is determined on the IPA matrix.
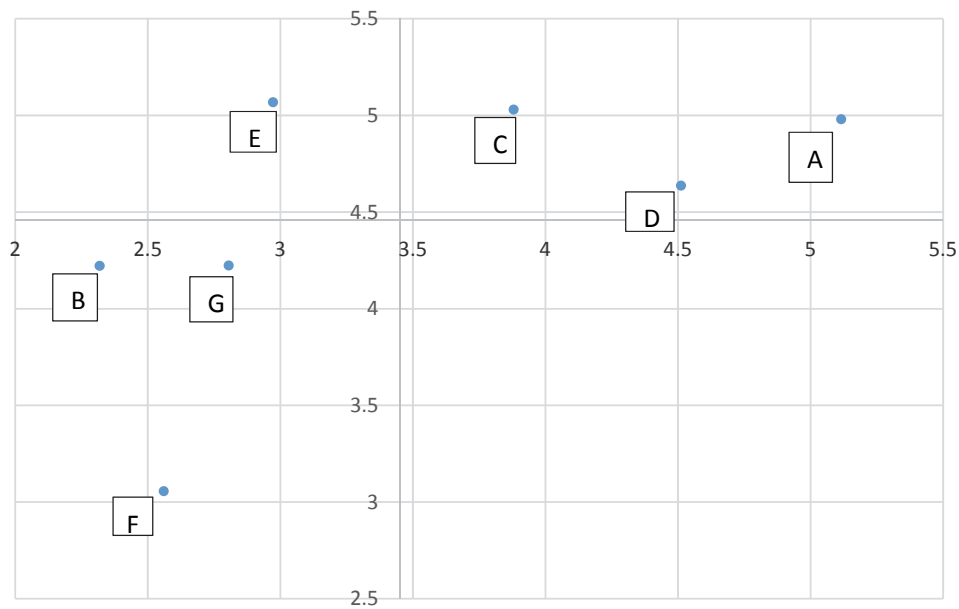
Fig. 3. Importance-performance analysis matrix of aspects

Three aspects A, C, and D are placed in the fourth quadrant (continue the good work). After the investigations are performed in the organization, it becames clear that these three aspects benefit from good strategies. For the same reason, these three aspects with the risk placeholder were selected as the inputs of the morphologic input. Currently, the mode of these three aspects in Saipa Company is as follows:

The project management aspect (A): management on the gates and deliveries of project (A4)

Technological technical aspect (C): the technique of modeling the today's products of the world's carmakers (C1)

The commercialization aspect (D): converting the customer's needs to the technical package (D1)

Placeholder (H): risk (H1)

The sixth step: the weight of the aspect j is shown with OW_j and it is calculated with $OW_j = |(b_j - c_j) \times b_j|$

In addition, it is normalized as $sw_j = \dfrac{ow_j}{\sum_{j=1}^{m} ow_j}$

Table 4
Weights and priorities of aspects

Code	Aspect	ow_i	sw_i	Priority
A	Project Management	0.669	0.020	6
B	System Management	8.042	0.242	2
C	Technological and Technical	5.797	0.174	4
D	Commercialization	0.591	0.018	7
E	Team Structure	10.634	0.320	1
F	Culture	1.520	0.046	5
G	Human Resources	5.995	0.180	3

Morphological Analysis

The first step: determining the parameters and problem aspects

First, the known aspects from the literature were considered as the problem parameters.

The second step: determining the modes in each of the aspects of the problem status

In this step, several modes for each of the aspects of the morphologic status of the research were defined in discrete mode (based on the morphological analysis suppositions) regarding to the responses of the experts on the questionnaire and interview and screening these ideas by the guide of some university professors; they are fully shown in Table 5:

Table 5
The variables of morphological analysis of the research with their code

Problem parameters	Decision options					
Project management (A)	Quality (A1)	Time (A2)	Cost (A3)	Gate, Milestone (A4)		
System management (B)	Micro management (B1)	Convincing (B2)	Democratic (B3)	Consulting (B4)	Non-intervention (B5)	
Technological, technical (C)	Modeling Technique (Benchmarking) (C1)	Reverse engineering (C2)	Platform designing (C3)	Joint venture (C4)	Accurate and complete defining of the piece features (C5)	Cooperation of piece producer in designing the product (C6)
Commercialization (D)	converting the customer's needs to the technical package (D1)	Using the need assessment models of the other carmakers (D2)	Changing the market and need (D3)	Mixed marketing (D4)		
Team structure (E)	Matrix-Project (E1)	Functional teams (E2)	Virtual team (external pear expert) (E3)	Shamrock (E4)		
Culture (F)	Flexible and dynamic (F1)	Structural (F2)	Risky (F3)	Organizational identity (F4)	Reward for innovation (F5)	
Human resources (G)	Knowledge management (G1)	Social capital management (G2)	Career path management(Personal development)(G3)	Empowerment (G4)		

Placeholder; the eighth aspect (H)

By adding an extra aspect to the known aspects from the literature of the research subject which is called the placeholder, two main ideas become accessible in the morphology method. The first is that the morphological model converts to a targeted status from the open and public status; and second is that, it will be possible to choose one of the placeholder modes and achieve the most compatible mode from the other aspects. The investigated different modes in placeholder of this study according to the will of experts are as follows:

1. The mode with the least risk (Risk)

2. The mode with the appropriate performance speed while accuracy (Agile)

3. The mode with the least wastes (Lean)

The third step: forming the morphological field configuration

The number of binary relationships between parameters; here, if N equals to the number of parameters in a morphological field, then the number of blocks (components) of parameter in the cross consistency matrix filed (number of comparisons) is as following:

$$\frac{1}{2}N(N-1)=\frac{1}{2}(8)(8-1)=28 \tag{7}$$

Identifying the simple configurations; to count the simple configurations, the below Formula is used.

$$T_{SC} = \prod_{i=1}^{n} V_i \tag{8}$$

Table 6
Counting the simple configurations

Code	Aspect	Number of modes	Morphological field configurations
A	Project management	4	
B	System management	5	The number of simple configurations
C	Technological, technical	6	$T_{SC} = \prod_{i=1}^{n} V_i$
D	Commercialization	4	
E	Team (structure)	4	
F	Culture	5	4*5*6*4*4*5*4*3
G	Human resources	4	=115200
H	placeholder	3	

As it can be observed from Table 4, the number of configurations of morphological field of the current study is 115000 combinations with eight members and they will be restricted by the cross consistency matrix.

The fourth step: cross consistency assessment matrix (CCM)

According to the formula, the number of comparisons must be done in the cross consistency assessment matrix is as follows:

$$C_t = \sum_{i=1}^{n-1}\sum_{j=2}^{n} V_i.V_j \tag{9}$$

Table 7
Cross consistency assessment matrix

Cross consistency assessment matrix	$V_i.V_j$
	4*(5)=20
Number of cells of Cross consistency assessment matrix (CCM)	6*(5+4)=54
	4*(5+4+6)=60
$C_t = \sum_{i=1}^{n-1}\sum_{j=2}^{n} V_i.V_j$	4*(5+4+6+4)=76
	5*(5+4+6+4+4)=115
	4*(5+4+6+4+4+5)=112
20+54+60+76+115+112+96= 533	3*(5+4+6+4+4+5+4)=96

After collecting the cross assessment questionnaires filled by "x" and "o" symbols, the integrated matrix of cross consistency assessment is determined like ISM method based on mode of comments. This integrated matrix represents 124 "x" type restrictions and 45 "o" type restrictions. After

elimination of the configurations with "x" type restriction, 140 configurations remained in the problem space. Then, with eliminating the configurations with "o" type restrictions, we reached four fully consistent configurations from 115200 configurations that can be observed in the tables 8, 9, 10, and 11. It must be mentioned that this has been resulted from filling more than 30 million excel cells.

Table 8

The consistent configuration number 1; row 7466

A4 Project management	B2 System management	C5 Technological, technical	D1 Commercialization	E4 Team (structure)	F5 Culture	G1 Human Resources	H3 Placeholder
Quality	Micro management	Modeling Technique (Benchmarking)	converting the customer's needs to the technical package	Matrix-Project	Flexible and dynamic	Knowledge	Risk
Time		Reverse engineering			Structural	Social capital	
	Convincing	Platform design	Using the need assessment models of the other carmakers	Functional teams	Risky		Agile
Cost	Democratic	Joint venture		Virtual team (external pear expert)	Organizational identity	Career path management (Personal development)	
Gate (Milestone)	Consulting	Accurate and complete defining of the piece features	Changing the market and need		Reward for innovation		lean
	Non-intervention	Cooperation of piece producer in designing the product	Mix marketing	Shamrock		Empowerment	

Table 9

Compatible configuration number 2, row 7858

A2 Project management	B4 System management	C6 Technological, technical	D4 Commercialization	E4 Team (structure)	F3 Culture	G4 Human Resources	H2 Placeholder
Quality	Micro management	Modeling Technique (Benchmarking)	converting the customer's needs to the technical package	Matrix-Project	Flexible and dynamic	Knowledge	Risk
		Reverse engineering			Structural		
Time	Convincing	Platform design	Using the need assessment models of the other carmakers	Functional teams	Risky	Social capital	Agile
Cost	Democratic	Joint venture		Virtual team (external pear expert)	Organizational identity	Career path management (Personal development)	
Gate (Milestone)	Consulting	Accurate and complete defining of the piece features	Changing the market and need		Reward for innovation		lean
	Non-intervention	Cooperation of piece producer in designing the product	Mix marketing	Shamrock		Empowerment	

Table 10

Compatible configuration number 3, row 50534

A4 Project management	B2 System management	C4 Technological, technical	D2 Commercialization	E4 Team (structure)	F1 Culture	G1 Human Resources	H3 Placeholder
Quality	Micro management	Modeling Technique (Benchmarking)	converting the customer's needs to the technical package	Matrix-Project	Flexible and dynamic	Knowledge	Risk
Time		Reverse engineering			Structural	Social capital	
	Convincing	Platform design	Using the need assessment models of the other carmakers	Functional teams	Risky		Agile
Cost	Democratic	Joint venture		Virtual team (external pear expert)	Organizational identity	Career path management (Personal development)	
Gate (Milestone)	Consulting	Accurate and complete defining of the piece features	Changing the market and need		Reward for innovation		lean
	Non-intervention	Cooperation of piece producer in designing the product	Mix marketing	Shamrock		Empowerment	

Table 11
Compatible configuration number 4, row 55921

A3	B2	C6	D4	E4	F5	G4	H3
Project management	System management	Technological, technical	Commercialization	Team (structure)	Culture	Human Resources	Placeholder
Quality	Micro management	Modeling Technique (Benchmarking)	converting the customer's needs to the technical package	Matrix-Project	Flexible and dynamic	Knowledge	Risk
Time		Reverse engineering			Structural	Social capital	
	Convincing	Platform design	Using the need assessment models of the other carmakers	Functional teams	Risky		Agile
Cost	Democratic	Joint venture		Virtual team (external pear expert)	Organizational identity	Career path management (Personal development)	
Gate (Milestone)	Consulting	Accurate and complete defining of the piece features	Changing the market and need		Reward for innovation		lean
	Non-intervention	Cooperation of piece producer in designing the product	Mix marketing	Shamrock		Empowerment	

Using the results obtained from IPA in GMA analysis

By using the result of IPA analysis in identifying aspects with simultaneous good performance and importance, the current organizational modes were selected as following and added to the morphologic model.

Project management aspect (A): managing the gates and project's deliveries (A4);

Technological technical aspect (C): technique of modeling from the today's products of the world's carmakers (C1);

Commercialization aspect (D): mixed marketing (D1);

Placeholder (H): Risk (H1);

The black cells represent the inputs of morphological model and the gray cells represent the obtained results.

Table 12
Configuration compatible with the IPA model's output, row 107317

A4	B3	C1	D4	E4	F5	G1	H3
Project management	System management	Technological, technical	Commercialization	Team (structure)	Culture	Human Resources	Placeholder
Quality	Micro management	Modeling Technique (Benchmarking)	converting the customer's needs to the technical package	Matrix-Project	Flexible and dynamic	Knowledge	Risk
Time		Reverse engineering			Structural	Social capital	
	Convincing	Platform design	Using the need assessment models of the other carmakers	Functional teams	Risky		Agile
Cost	Democratic	Joint venture		Virtual team (external pear expert)	Organizational identity	Career path management (Personal development)	
Gate (Milestone)	Consulting	Accurate and complete defining of the piece features	Changing the market and need		Reward for innovation		lean
	Non-intervention	Cooperation of piece producer in designing the product	Mix marketing	Shamrock		Empowerment	

6. Conclusion

The results obtained from this study will significantly contribute to the senior organizational decision makers in the field of the multiple aspects of the new product development problem. Due to the lack of public access to MA/Carma software, we can observe a few papers with morphological analysis in the world. In this study, we have tried to provide a domestic solution to solve the morphologic model and develop the morphological analysis method through an innovative method in Microsoft Excel software environment. The frequent variables such as management and control of the new product project, management ruling the organization, the type of the used technology and function method, commercialization of the developed products, the structure of the product development teams, the dominant and contextual culture of the organization, the treatment and the human resources management in order to maintain the quality were from the qualitative known variables in this study.

After determining the situation of each of the aspects in the four parts IPA matrix, three aspects were placed in the second quadrant (continue the work well). After the required investigations and determining the mode situation of these three aspects in Saipa Company, three modes of the project management in gates, using modeling technique in the technical aspect, and converting the customer will to the technical packages and product manufacturing in commercialization aspect were considered as the input of morphological model; and selecting the risk placeholder by the experts in investigations represented that the most consistent possible mode was in row 107,317 with four outputs of democratic senior management, shamrock team structure, the culture of reward for innovation, and knowledge management in the human resources aspect.

The notable point in the results of this research is that in the team (structure) aspect, all fully consistent configurations have the mode (option) E4, i.e. "shamrock" structure. Shamrock is the national symbol of Ireland and a small plant with three leaves on each of its shoots. In the early 1990s, Charles Hindi predicted that the future organizations would be shamrock organizations. These organizations would be more virtual organizations instead of having physical aspects; and determined the non-strategic activities in the value chain and assigned them to the external units. With this method, the costs of the organization would decrease and the management power would be spent in the fundamental activities. The structure of the shamrock organization is fully different from the traditional organizations. The number of management layers in the shamrock organizations would decrease and the management would be more a professional activity instead of being the symbol of a luxury and high-class level in the organization.

In terms of adopting with the theory of Hindi, it can be claimed that the prediction done on the shamrock structure is very flexible and functionally consistent with different configurations. Of course, to prove this theory, we will require a comprehensive research. The researcher recommends that the organizations that are more knowledge-based in terms of their work study and examine this plan in trial in order to complete their human resources needs. So that, the benefits and disadvantages of the shamrock organization will be comprehensively observed and it can give the human resources section a guide map.

The researcher recommends the managers of the profession-based systems requiring high innovation and creativity not to use the magnifying and democratic management methods. On one hand, the basic conflicts in the profession-based system with the need of an accurate and magnifying managerial look, and on the other hand, the creativity requirements with unlimited need of aesthetic and artistic mode are from the largest conflicts in the new product development. In the four selected patterns in this study, it was shown that the micro management is severely in conflict with the nature of the new product development. On the other hand, regarding to the fact that the democratic management emphasizes on the equality of votes and consensus on decision, it may only satisfy the innovation sense, fail in professionalism and its principled visions, and develop an attractive but unpractical and inefficient product.

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In addition, this study indicated that the purity of the process of new product development could be considered as a strategy and a key success factor in this field. The researches recommend to the studied organizations and the other industrial organizations of the country that along with all activities leading to the product development, it is better to pay attention to decrease in wastes (including time, cost, tiredness of workforce, working repeatedly, etc.) with the aim of purity and continuous quality of the process.

It is suggested that the other researchers of the operational research develop the field of morphological analysis through integrating the multi-criteria decision making methods and the general morphological analysis like DEMATEL, TOPSIS, ANP, etc. Since the morphological method has been hardly ever used in the international scientific papers, development, integration, and extending this method can create a unique chance for the operational research participants.

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