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Ranking the success factors of NPD with a WCM approach (Case study: Active companies in the food industry)

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Abstract

In today's world, increasing demand changes, intense competition, shortening the product life cycle, and on the other hand, the movement of manufacturing towards globalization has forced organizations and companies to develop new products globally. Therefore, the purpose of the present study was to rank the success factors of NPD with a WCM approach in Iran. In the first part of the research, 14 interviews were conducted with professors, experts, and managers of the food industry. After conducting interviews and collecting data, the codes obtained in different sections were analyzed using the grounded theory. After performing the three open, axial, and selective coding steps, the final model was obtained. In this research, Atlas-ti software has been used to analyze the data. The final model consists of a set of causal conditions, underlying conditions, intervention conditions, main categories, strategies, and finally, the consequences and results of the success of NPD with a WCM approach in the food industry. Each of these conditions and the factors that make up the model has variables and categories that pay attention to them to achieve the ultimate goal of designing a model for the success of NPD with a WCM approach. In the second part of the research, the relationship between the variables was examined using a pairwise comparison questionnaire, and the data were analyzed using the fuzzy BWM method using Lingo software.

Keywords: New product development (NPD), World class manufacturing (WCM), Food industry
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1 Introduction

Today, the food sector is one of the most important sectors of the economy and has been considered by various officials and organizations [13]. Despite the importance of this sector globally, companies operating in the food industry still face many challenges in managing their products and competing in the market [22]. In fact, over the years, the rate of change has also affected food companies, pushing them to focus on innovation to maintain or gain a competitive advantage. In this regard, there are various challenges in these companies, and most of them are related to changing the stimuli and creating new demands for product development. Successful companies, therefore, need to understand and accept these challenges and find ways to address them through processes and solutions focused on innovation

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and New Product Development (NPD) [17]. The success of new products is the best element of a company's survival or success [19]. The food industry is no exception. In this industry, there is a rapid change in customer tastes and the use of new technologies, just like in other industries [30]. Therefore, since the failure of new products in practice entails high costs for organizations, the need for planning with a competitive approach has led companies to use appropriate approaches in the direction of competition. Therefore, the development of new products is considered as a competitive strategy through which companies want to improve their products competitively. At the same time, artificial intelligence systems and decision support help decision-makers, especially food industry managers, to avoid the high costs of product development [28]. Thus, given the increasing competition in markets and the growing economic crisis that has affected most manufacturing industries around the world [5], companies are under pressure to reduce costs and reduce quality. Improve and eventually produce more efficient products [7]. As a result, many companies are looking for solutions to improve their manufacturing performance to examine their manufacturing strategies to see if they are useful and sufficient to meet the ever-increasing demands of international markets or not [7]. Therefore, the use of World WCM (WCM) techniques as a convincing tool for manufacturing companies with a specific end goal is designed to introduce themselves in a competitive environment of a brand. Using these methods improves the method, improves productivity, improves quality, and reduces costs for firms, and these facilities can help the company to be raised globally [24].

According to the previous research, it has been determined that all the researches in the field of ranking the success factors and the development of the new product have been done in a very detailed way with the WCM approach. Therefore, in this research, we have tried to examine all the factors of product development success according to world standards and WCM, past research, review of experts' opinions, and use of industry data and its results to design a model for product success with WCM approach.

2 Literature review

In this part of the research, the theoretical literature and the review of internal and external research related to the present study are discussed.

2.1 Theoretical foundations

2.1.1 WCM

Every company knows what world-class means, but few companies are among the best in the world in terms of their activities. WCM technology is an advanced manufacturing technology that is specifically designed to produce standard products with international accreditation and in accordance with international standards [18]. By implementing WCM, the costs of manufacturing operations can be reduced by eliminating elements that have no added value or cause damage, loss, and even lead to accidents and errors. WCM as a management model includes its own methods and tools that enable the company to achieve profit and competitive advantage based on the principle of producing the highest quality products at the lowest price. The WCM model is based on four concepts: zero loss, zero crash, zero breakdowns, and zero reserves. A prerequisite for developing a WCM model is the improvement of the company's organizational system to achieve a global level of competition [15]. What researchers have in common is that, philosophically, an organization achieves WCM status. To be able to successfully combine manufacturing capacity to support the entire organization in achieving a sustainable competitive advantage in the areas of cost, quality, delivery, flexibility, innovation, and customer service [26].

2.1.2 NPD

A product can be defined as a useful whole. That is why we say that a product is a tangible substance with physical properties and a comprehensive image in the consumer's mind that creates an acceptable expectation of meeting his needs [16]. There are several definitions of a new product; for example, NPD is the process of designing a new product, and producing and marketing it. Most new food products, especially those produced by small and medium-sized companies, are produced based on company-specific NPD methods or models compatible with other sectors [21]; in other words, product development. The new can be defined as the process of transforming a new market opportunity into a business product through a sequence of activities to achieve specific goals [31].

2.2 Research background

In connection with the success of NPD with the WCM approach, some research has been done, and we will mention a number of these researches.

De Felice et al. [6] conducted a study entitled Previous Studies and the differences between lean management and WCM. The purpose of the present study was to evaluate the relationship between pure methods and WCM to clarify their integration and achieve global manufacturing performance in an airline in Italy to analyze the data from the series analysis process methods. Analytical Hierarchy Processes (AHP) have been used to determine the complete ranking of lean strategies and WCM parameters, and the fuzzy cognitive mapping method has been used to infer the relationship between lean management parameters and WCM success factors. In this research, pure dimensions include manufacturing process and equipment, manufacturing planning and planning, visual information system, product, and technology development, labour management, supplier relations, and customer relations, and WCM dimensions include safety, cost, continuous improvement, freedom of action, professional maintenance, quality control, logistics and customer service, basic equipment management, human development and environment. The results of the research show that lean methods are as important as WCM, and there is a strong correlation between lean dimensions and WCM. Also, the results of the research have shown that among the pure dimensions of product and technology development, it has the highest rank, and among the dimensions of WCM, safety has the highest rank. It is also desirable to reduce material waste by increasing quality and investing in product development, safety, and the environment.

Khorasgani et al. [12] conducted a study entitled design of a sustainable manufacturing model in the manufacturing of WCM in the automotive industry in Iran. This study is applied in terms of purpose and descriptive-survey research. In this method, data collection is library and field, and the most important dimensions and criteria of a sustainable WCM model have been screened and localized by reviewing the theoretical literature and interviewing experts and specialists and fuzzy Delphi techniques. After collecting data through a pairwise comparison questionnaire, the data were analyzed using the combined technique of the next fuzzy network analysis process. Fuzzy DEMATEL findings have shown that the dimensions of sustainability are environmental (environmental pollutants, protection of natural resources, use of recyclable raw materials, use of organic raw materials, responsiveness, energy), economic (employment, innovation, cost), Operational, productivity, financial health) and social (participation in social events, employee satisfaction, human capital empowerment, compliance with civil laws, community health, and customer satisfaction) contribute to achieving world-class sustainable manufacturing.

Roy et al. [23] conducted a study entitled the role of the product development process for the success of NPD in the Indian manufacturing industry: quality, cost, and technology. This study collected preliminary data by a semi-structured questionnaire with a 9-point Likert scale of 263 experts in manufacturing design and development in Indian manufacturing companies. In this study, Cronbach's alpha was used to confirm the reliability, and convergent validity was used to confirm the validity. The AHP is used to rank the factors, and Structural Equation Modeling (SEM) is used to analyze the hypotheses. The results of this study show that the NPD process is one of the most important factors in the success of NPD, which requires the support of top management, external cooperation, and market analysis to produce high-quality products and technological advances to reduce costs and provide a good platform for the success of NPD. Among the mentioned factors, the support of the top management of the organization has the most impact on the NPD process, and market analysis and foreign cooperation are in the next rank, and among the quality, cost, and technology factors, the quality of the new product has the most impact. Are on NPD, and product and technology costs are in the next ranks.

Li et al. [14] conducted a study entitled new product idea selection in the fuzzy front end of innovation: a Fuzzy best-worst method and group decision-making process. In this study, the domain of new product idea selection is focused on and enhanced by means of the multi-criteria decision making (MCDM) approach, in which multiple criteria and sub-criteria can be considered in the selection process. Among a number of MCDM approaches, the fuzzy set theory and best-worst method (BWM) are integrated as the fuzzy BWM in this study to structure the new product idea selection process under a group decision-making process. In this paper, with the goal of the new product idea selection, five criteria are summarised: finance, marketing, engineering, manufacturing, and sustainability, which are the major dimensions for evaluating the new product ideas. The results show that finance is the best criterion, while manufacturing is the worst criterion.

Dashtianeh et al. [3] performed a study entitled identifying and ranking NPD critical factors based on marketing strategy case study Esfahan Steel Co.In this study, initially, critical factors in successful NPD at Esfahan Steel Co. are identified using a systematic literature review. Later, by using the information provided from the HR and marketing department of the Esfahan Steed Co., the designed questionnaire is asked to be filled by expertise, suppliers, and customers. The collected data is analyzed by Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), and the main parameters affecting successful NPD are identified. In this study, fifteen factors are extracted from the literature and ranked by the TOPSIS method. All of the fifteen factors are divided into five main categories: customer behavior, supplier, market, government strategy, and social media. The results showed that the customer's

needs and government role are the most crucial factor in the alloy market.

3 Methodology

In the first part of the research, after analyzing the data, it was found that 107 categories and 20 criteria were classified into sections. The research results are presented in the form of the following theorems.

3.1 In the present study, based on the components of the pivotal coding stage with reference to the foundation grounded theory method, the following theorems have been obtained

Theorem 1: Appropriate strategies, market orientation, and customer dynamics, as causal conditions, affect the design of a successful product development model with a WCM approach in the food industry.

Theorem 2: Organizational factors, customer characteristics, and environmental conditions as underlying conditions affect the design of a successful model for the development of new products with a WCM approach in the food industry.

Theorem 3: Flexibility, customer interactions, and service development and improvement as key strategies influence the design of NPD success models with a WCM approach in the food industry.

Theorem 4: Customer, managerial and organizational barriers, structural barriers, and characteristics of the food industry, as intervention conditions, affect the design of a successful NPD model with a WCM approach in the food industry.

Theorem 5: Food policies, formulation and approval, and rationality of policies, introduction, and provision of services to customers, the organization as central factors affect the design of a model for the success of NPD with a WCM approach in the food industry.

Theorem 6: Causal conditions, underlying conditions, intervention conditions and strategies, consequences of the agenda of designing a successful model for NPD with a WCM approach in the food industry in Iran, market development and strengthening the position of the food industry, increasing customer satisfaction and financial consequences will follow.

3.2 Fuzzy best-worst method

In the second part of the research, a pairwise comparison questionnaire was used to collect data in the present study. The statistical population consisted of 14 professors and experts in the field of the food industry, and the analysis was performed using the fuzzy BWM method and Lingo software. This method was first proposed by Guo and Zhao [11]. Its algorithm is similar to the best-worst-definite method. The use of fuzzy numbers due to the verbal ambiguities of the respondents causes more accuracy and better results in calculations. The steps of this method are as follows: Assume that there are n criteria. The pairwise comparisons of these n criteria are compared with each other through the verbal expressions in Table 1, i.e., the verbal expressions of the respondents are converted into corresponding fuzzy numbers according to Table 1.

Step 1. Create a benchmark decision system

In this step, we extract the research criteria that we intend to compare, which include n criteria for evaluation.

Step 2. Determine the best (most important) criterion and the worst (least important) criterion

In this step, the most important and least important criteria should be determined as the best and worst criteria, which can be obtained from experts' opinions, group meetings, or methods such as Delphi. We give the best criterion with CB and the worst criterion with CW.

Step 3. The pairwise comparisons of the best criterion pair with other criteria

In this step, using table 1, the comparison of a_{ij} must be determined. The i is the best criterion, i.e., CB and j are the other criteria. Comparing the best criterion with the worst criterion should always be the highest number of the rest. Also, the pairwise comparisons of a_{BB} are equal to (1,1,1). In general, the comparison is as follows:

$$\widetilde{A}_B = (\widetilde{a}_{B1}, \widetilde{a}_{B2}, ..., \widetilde{a}_{B3}).$$

Step 4. The pairwise comparisons of other criteria with the worst criteria

Table 1: Verbal expressions and fuzzy numbers for pairwise comparisons

Code	Priorities	The fuzzy equivalent of priorities		
		Lower limit (l)	Lower limit (l)	Lower limit (l)
1	Equal importance	1	1	1
2	The same to relatively important	1	2	3
3	Relatively important	2	3	4
4	Relatively crucial to very important	3	4	5
5	Very important	4	5	6
6	Very important to very much important	5	6	7
7	Very much important	6	7	8
8	Very much important to absolutely important	7	8	9
9	Absolutely important	8	9	10

In this step, as in the third step, the other criteria are compared with the worst criteria according to Table 1. The pairwise comparison examined in this step is a_{1B}. Also, the pairwise comparison of a_{ww} is equal to (1,1,1). In general, the comparison is as follows:

$$\widetilde{A}_w = (\widetilde{a}_{1w}, \widetilde{a}_{2w}, ..., \widetilde{a}_{3w}).$$

Step 5. Determine the optimal weights $(\widetilde{W}_1^*, \widetilde{W}_2^*, ..., \widetilde{W}_n^*)$

The optimal weight for the criteria is the weight at which the following equation holds for each pair $\frac{\widetilde{W}_b}{\widetilde{W}_j}$ and $\frac{\widetilde{W}_j}{\widetilde{W}_w}$.

$$\frac{\widetilde{W}_b}{\widetilde{W}_j} = \widetilde{a}_{Bj}, \quad \frac{\widetilde{W}_j}{\widetilde{W}_w} = \widetilde{a}_{jw}.$$

To establish these conditions for all js, we must find a solution in which the maximum absolute difference, that is, $\frac{\widetilde{W}_b}{\widetilde{W}_j} - \widetilde{a}_{Bj}$ and $\left|\frac{\widetilde{W}_j}{\widetilde{W}_w} - \widetilde{a}_{jw}\right|$ is minimum for all js.

Considering that the scales and conditions of weight addition are not negative, the following problem is obtained.

$$\begin{aligned} \min \max_J & \left\{ \left| \frac{\widetilde{W}_b}{\widetilde{W}_j} - \widetilde{a}_{Bj} \right|, \left| \frac{\widetilde{W}_j}{\widetilde{W}_w} - \widetilde{a}_{jw} \right| \right\} \\ s.t. \quad & \sum_j R(\widetilde{W}_j) = 1 \\ & l_j^w \le m_j^w \le u_j^w, \quad l_j^w \ge 0 \qquad \text{For all } js \end{aligned} \tag{3.1}$$

In this relation, $R(\widetilde{a}_i) = \frac{l_i + 4m_i + u_i}{6}$.

The model problem of Equation (3.1) can be turned into the following problem.

$$\begin{aligned} & \min \widetilde{\xi} \\ & s.t. \\ & \left| \frac{\widetilde{W}_b}{\widetilde{W}_j} - \widetilde{a}_{Bj} \right| \le \widetilde{a} \quad \text{For all } js \\ & \left| \frac{\widetilde{W}_j}{\widetilde{W}_w} - \widetilde{a}_{jw} \right| \le \widetilde{a} \quad \text{For all } js \\ & \sum_j R(\widetilde{W}_j) = 1 \\ & l_j^w \le m_j^w \le u_j^w, \quad l_j^w \ge 0 \quad W_j \ge 0, \text{ for all } js \end{aligned} \tag{3.2}$$

By solving the above problem, the optimal weights $(\widetilde{W}_1^*, \widetilde{W}_2^*, ..., \widetilde{W}_n^*)$ and $\widetilde{\xi}$ are obtained.

In the following, using $\widetilde{\xi}$, we introduce the compatibility ratio. The larger the value of $\widetilde{\xi}$, the higher the value of the compatibility ratio and the less reliable the comparisons.

Step 6. Incompatibility rate

The comparison is fully compatible when the following equation holds for all js. $a_{BW} = a_{Bj} \times a_{jw}$ where a_{Bj}, a_{jw} and a_{BW} will be the priorities of the best criterion over the criterion j, the priority of the criterion j over the worst criterion, and the priority of the best criterion over the worst criterion, respectively. Since $a_{BW} = a_{Bj} \times a_{jw}$ and $a_{BW} \in \{1, 2, 3, ..., 9\}$, the maximum value of ξ can be obtained. Using the compatibility index of the table below and its relationship, the value of the incompatibility rate was calculated. This rate of incompatibility is in the range [0 1] and the closer it is to zero, the more compatible and compatible the comparisons are, and the closer it is to one, the less compatible and compatible the comparisons are.

The compatibility index can be calculated through the following equation.

$$\xi^2 - (1 + 2u_{BW})\xi + (u_{BW}^2 - u_{BW}) = 0 \tag{3.3}$$

4 Data analysis

In this part of the research, the results of the method are given. In this section, the best worst fuzzy method is used to weight and prioritize research factors.

Initially, the most important and least important indicators were performed for each of the main criteria. In order to perform this principle in the first step, the best-worst method must be the most important (best) and the least important (worst) The index should be specified that in this research, using the opinions of 14 research experts, the best and the worst are given below. In the next step, pairwise comparisons of the best criteria against other criteria (BO) and other criteria against the worst criteria (OW) are performed. In this study, pairwise comparisons were first made and provided to 14 experts to be based on the table 2 fuzzy to determine the degree of preference in pairwise comparisons after answering, the pairwise comparisons were merged with the geometric mean method and finally the weight of the criteria was calculated. But Guo and Zhao [11] stated that in models with three or more criteria, it is better to make the model linear. Therefore, the linear model of fuzzy BWM method was formed and solved by Lingo 17 software and the criteria weights were obtained, which are given below.

4.1 The main criteria of main categories are the design of a model for the success of NPD with a WCM approach

Determine the most important and least important indicators

1. The third criterion (C3): introducing and providing services to customers
2. The first criterion (C1): food policies

Table 2: The pairwise comparison of the main criteria of main categories of designing a model for the success of NPD with a WCM approach

		C1	**C2**	**C3**	**C4**
The best criterion	C3	(4.52,5.683,6.768)	(4.043,5.283,6.402)	(7.67,8.674,9.677)	(4.562,5.598,6.619)
The worst criterion	C1	(1,1.414,1.732)	(1.072,1.692,2.221)	(1.072,2.083,3.088)	(1.414,2.011,2.521)

Table 3: Weight and final rank of the main criteria of main categories of design a model for the success of NPD with a WCM approach

Rank	**Definite weight**	**Fuzzy weight**	**Code**	**Criterion**
4	0.0659	(0.0552,0.0628,0.0888)	C1	Food policies
2	0.1621	(0.1223,0.1662,0.1853)	C2	Codification and approval and rationality of policies
1	0.3289	(0.3289,0.3289,0.3289)	C3	Introducing and providing services to customers
3	0.0894	(0.082,0.082,0.1265)	C4	Organizing

In Table 3, the fuzzy weights are obtained directly from solving the model in Lingo software. Then, these fuzzy weights are converted to a definite weight by the relation $R(\widetilde{a}_i) = \frac{l_i+4m_i+u_i}{6}$. For example, the fuzzy weight of criterion C1 is (0.0552, 0.0628, 0.0888) whose definite weight is equal to

$$\frac{0.0552 + 4 \times 0.0628 + 0.0888}{6} = 0.0659$$

4.1.1 Food policy sub-criteria

Determine the most important and least important indicators

1. The second criterion (C2): examining the effect of policy on key factors in the development of new products
2. The third criterion (C3): the general orientation of the food industry

Table 4: Final weight and rank of food policy sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
2	0.153	(0.129, 0.183, 0.243)	C1	Guide to making decisions in the field of food industry
1	0.205	(0.168, 0.243, 0.334)	C2	Examining the effect of policy on key factors in the development of new products
3	0.112	(0.088, 0.131, 0.195)	C3	the general orientation of the food industry

4.1.2 Codification and approval and rationality of policies sub-criteria

Determine the most important and least important indicators

1. The fourth criterion (C4): codification and approval and rationality of policies
2. The third criterion (C3): transparency of organizational policies

Table 5: Final weight and rank of the criteria for codification and approval and rationality of policies

Rank	Definite weight	Fuzzy weight	Code	Criterion
2	0.297	(0.480, 0.396, 0.117)	C1	Environmental and organizational constraints
4	0.175	(0.335, 0.210, 0.089)	C2	Time, information and resources constraints
5	0.091	(0.190, 0.080, 0.117)	C3	Transparency of organizational policies
1	0.498	(0.467, 0.709, 0.380)	C4	Codification and approval and rationality of policies
3	0.235	(0.600, 0.208, 0.189)	C5	Codification policies senior managers

4.1.3 Sub-criteria of introducing and providing services to customers

Determine the most important and least important indicators

1. The sixth criterion (C6): providing services to customers
2. The fourth criterion (C4): transparency of organizational policies

Table 6: Final weight and rank of sub-criteria for introducing and providing customer service

Rank	Definite weight	Fuzzy weight	Code	Criterion
3	0.308	(0.389, 0.350, 0.410)	C1	Monitor customers and competitors
4	0.248	(0.208, 0.381, 0.139)	C2	Target customer analysis
5	0.135	(0.113, 0.207, 0.080)	C3	Create value
6	0.075	(0.086, 0.104, 0.055)	C4	Service enrichment
2	0.350	(0.550, 0.480, 0.112)	C5	Introduce customer service
1	0.677	(0.655, 0.980, 0.470)	C6	Provide customer service

4.1.4 Organizing sub-criteria

Determine the most important and least important indicators

1. Criterion (C1) Market development by using advertisements
2. The second criterion (C2): changing the attitude of customers

Table 7: Final weight and rank of organizing sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
1	0.386	(0.670, 0.420, 0.387)	C1	Market development by using advertising
2	0.174	(0.500, 0.113, 0.206)	C2	Changing customer attitudes

4.2 The main criteria of strategies for designing a model for the success of NPD with a WCM approach are to determine the most important and least important indicators

1. The first criterion (C1): flexibility
2. The third criterion (C3): focus on services

Table 8: Final weight and rank of the main criteria for strategies of designing a model for the success of NPD with a WCM approach

Rank	Definite weight	Fuzzy weight	Code	Criterion
1	0.526	(0.549, 0.670, 0.597)	C1	Flexibility
2	0.224	(0.320, 0.218, 0.370)	C2	Customer interactions
3	0.199	(0.180, 0.290, 0.148)	C3	Focus on services

4.2.1 Flexibility sub-criteria

Determine the most important and least important indicators

1. The fourth criterion (C4): utilizing elites and experts with experience in the food industry for policy making
2. The third criterion (C3): flexibility of the manufacturing system

Table 9: Final weight and rank of the main criteria for strategies of designing a model for the success of NPD with a WCM approach

Rank	Definite weight	Fuzzy weight	Code	Criterion
2	0.348	(0.558, 0.410, 0.300)	C1	Flexibility of supply chain
3	0.252	(0.420, 0.308, 0.170)	C2	Flexibility of organizational structure and processes
4	0.113	(0.016, 0.208, 0.042)	C3	Flexibility of manufacturing system
1	0.558	(0.640, 0.778, 0.375)	C4	Utilizing elites and experts with experience in the food industry for policy making

4.2.2 Customer interaction sub-criteria

Determine the most important and least important indicators

1. The second criterion (C2): information systems for recording customer information to check ideas
2. The third criterion (C3): the development of customer loyalty programs, including discounts to customers or awarding prizes.

4.2.3 Service Focus sub-criteria

Determine the most important and least important indicators

1. The second criterion (C1): increase the diversity and quality of services
2. The third criterion 3 (C2): focus on specific markets

Table 10: Final weight and rank of sub-criteria for customer interaction

Rank	Definite weight	Fuzzy weight	Code	Criterion
2	0.316	(0.340, 0.419, 0.300)	C1	Continuous and regular assessment of customer behavior and attitude
1	0.611	(0.487, 0.864, 0.588)	C2	Information systems for recording customer information to check ideas
3	0.146	(0.114, 0.203, 0.158)	C3	The development of customer loyalty programs, including discounts to customers or awarding prizes.

Table 11: Final weight and rank of focus on service sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
1	0.618	(0.571, 0.804, 0.729)	C1	Increase the diversity and quality of services
3	0.224	(0.143, 0.280, 0.364)	C2	Focus on specific markets
2	0.480	(0.548, 0.649, 0.388)	C3	Appropriate rules for returning food of inadequate quality

4.3 The main criteria of intervention conditions are the design of a model for the success of NPD with a WCM approach

Determine the most important and least important indicators

1. The third criterion (C3): structural barriers
2. The first criterion (C1): customer

Table 12: Final weight and rank of the main criteria of intervention conditions of success model design of NPD with a WCM approach

Rank	Definite weight	Fuzzy weight	Code	Criterion
4	0.0831	(0.072, 0.106, 0.109)	C1	Customer
2	0.317	(0.430, 0.387, 0.313)	C2	Managerial and organizational barriers
1	0.632	(0.535, 0.849, 0.714)	C3	Structural barriers
3	0.204	(0.182, 0.270, 0.237)	C4	Characteristics of food industry

4.3.1 Customer sub-criteria

Determine the most important and least important indicators

1. The first criterion (C1): no feedback from customers
2. The second criterion (C2): lack of attention to the needs of domestic and foreign customers

Table 13: Final weight and rank of customer sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
1	0.520	(0.530, 0.628, 0.708)	C1	No feedback from customers
2	0.409	(0.365, 0.540, 0.470)	C2	Lack of attention to the needs of domestic and foreign customers

4.3.2 Managerial and organizational barriers sub-criteria

Determine the most important and least important indicators

1. Third criterion (C3): weakness in upstream food industries, especially packaging industries
2. The fifth criterion (C5): fluctuations in the prices of manufactured goods

Table 14: Weight and final rank of sub-criteria of managerial and organizational barriers

Rank	Definite weight	Fuzzy weight	Code	Criterion
4	0.364	(0.548, 0.410, 0.406)	C1	High volume of traditional products
5	0.224	(0.180, 0.290, 0.299)	C2	High level of cost to build infrastructure
1	0.627	(0.855, 0.718, 0.756)	C3	Weakness in upstream food industries, especially packaging industries
2	0.520	(0.510, 0.635, 0.706)	C4	Small scale of manufacturing industries
6	0.188	(0.356, 0.138, 0.350)	C5	Fluctuations in the prices of manufactured goods
3	0.421	(0.488, 0.508, 0.519)	C6	Lack of a single standard in product quality assessment

4.3.3 Food industry characteristics sub-criteria

Determine the most important and least important indicators

1. The fourth criterion (C4): inadequate tools and equipment
2. The first criterion (C1): unprofessional policy in food tariffs

Table 15: Final weight and rank of food industry characteristics sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
5	0.133	(0.114, 0.210, 0.055)	C1	High volume of traditional products
2	0.349	(0.415, 0.388, 0.520)	C2	High level of cost to build infrastructure
4	0.175	(0.277, 0.216, 0.130)	C3	Weakness in upstream food industries, especially packaging industries
1	0.472	(0.510, 0.480, 0.886)	C4	Small scale of manufacturing industries
3	0.312	(0.418, 0.378, 0.322)	C5	Fluctuations in the prices of manufactured goods

4.4 The main criteria of underlying conditions of design a model for the success of NPD with a WCM approach

Determine the most important and least important indicators

1. The first criterion (C1): organizational factors
2. The second criterion (C2): customer characteristics

Table 16: Weight and final rank of the main criteria of underlying conditions of design a model for the success of NPD with a WCM approach

Rank	Definite weight	Fuzzy weight	Code	Criterion
1	0.389	(0.635, 0.490, 0.229)	C1	Organizational factors
3	0.088	(0.119, 0.087, 0.149)	C2	Customer characteristics
2	0.239	(0.238, 0.283, 0.410)	C3	Environmental conditions

4.4.1 Organizational factors sub-criteria

Determine the most important and least important indicators

1. The second criterion (C2): access to technologies
2. The eight criterion (C8): different religious views on foreign food

4.4.2 Customer characteristics sub-criteria

Determine the most important and least important indicators

1. The fourth criterion (C4): high tendency to use organic food
2. The fifth criterion (C5): the high importance of products in preventing malnutrition

Table 17: Weight and final rank of sub-criteria of organizational factors

Rank	Definite weight	Fuzzy weight	Code	Criterion
2	0.401	(0.608, 0.430, 0.510)	C1	Traditional food industry organizational structure
1	0.646	(0.711, 0.852, 0.610)	C2	Access to technologies
4	0.307	(0.637, 0.599, 0.613)	C3	Various cumbersome rules on issuing manufacturing licenses
5	0.162	(0.290, 0.165, 0.188)	C4	Increase manpower productivity
6	0.153	(0.210, 0.187, 0.150)	C5	Quick and flexible access to complementary resources and skills of other companies
7	0.081	(0.176, 0.069, 0.108)	C6	Culture building
3	0.309	(0.319, 0.377, 0.401)	C7	Differences in policies and strategies regarding the importance of the food industry
8	0.037	(0.091, 0.040, 0.017)	C8	Different religious views on foreign food

Table 18: Final weight and rank of customer characteristics sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
4	0.239	(0.280,0.312,0.220)	C1	High number and dispersion of customers
3	0.340	(0.430,0.399,0.418)	C2	Market (and product) diversity
2	0.390	(0.558,0.415,0.509)	C3	Customer values, and expectations
1	0.615	(0.548,0.749,0.897)	C4	High tendency to use organic food
5	0.117	(0.129,0.158,0.104)	C5	The high importance of products in preventing malnutrition

4.4.3 Environmental conditions sub-criteria

Determine the most important and least important indicators

1. The sixth criterion (C4): high fluctuations in raw material prices
2. The ninth criterion 9 (C5): Lack of proper distribution networks

Table 19: Weight and final rank of sub-criteria of environmental conditions

Rank	Definite weight	Fuzzy weight	Code	Criterion
5	0.245	(0.700,0.128,0.389)	C1	Economic fluctuations
9	0.045	(0.087,0.054,0.023)	C2	Existence of comprehensive sanctions
3	0.311	(0.480,0.344,0.358)	C3	Existence of currency fluctuations and changes in the prices of domestic and foreign raw materials
4	0.297	(0.419,0.360,0.286)	C4	Benefit from government policies
8	0.0263	(0.088,0.011,0.037)	C5	Outsourcing cost management
1	0.640	(0.694,0.786,0.790)	C6	High fluctuations in raw material prices
2	0.492	(0.509,0.639,0.526)	C7	Lack of proper infrastructure in packaging
7	0.133	(0.154,0.181,0.105)	C8	The parallel development - scalability of resources, monitoring and operation of technical regulations and standards
6	0.151	(0.300,0.165,0.113)	C9	Lack of proper distribution networks

4.5 The main criteria of causal conditions of design a model for the success of NPD with a WCM approach

Determine the most important and least important indicators

1. The third criterion (C3): customers
2. The second criterion (C2): market orientation

Table 20: Weight and final rank of the main criteria of causal conditions of design a model for the success of NPD with a WCM approach

Rank	Definite weight	Fuzzy weight	Code	Criterion
2	0.436	(0.642, 0.529, 0.388)	C1	The appropriate strategy
3	0.378	(0.417, 0.511, 0.318)	C2	Market orientation
1	0.582	(0.459, 0.735, 0.831)	C3	Customers

4.5.1 The appropriate strategy sub-criteria

Determine the most important and least important indicators

1. The sixth criterion (C6): determining appropriate pricing strategies
2. The second criterion (C2): the use of multi-purpose teams

Table 21: Weight and final rank of sub-criteria of appropriate strategy sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
3	0.428	(0.479,0.530,0.501)	C1	Promote the competitiveness of firms in the food industry
7	0.141	(0.150,0.196,0.108)	C2	The use of multi-purpose teams
4	0.286	(0.415,0.309,0.375)	C3	The importance of innovation as a core strategy
2	0.457	(0.611,0.548,0.490)	C4	Customer orientation as the main goal of employees and the organization
6	0.168	(0.114,0.280,0.054)	C5	Merge small firms to reduce additional costs
1	0.550	(0.590,0.658,0.738)	C6	Determine appropriate pricing strategies
5	0.209	(0.287,0.266,0.169)	C7	Grounding the creation of downstream industries in obtaining the required raw materials

4.5.2 Market orientation sub-criteria

Determine the most important and least important indicators

1. The fourth criterion (C4): commitment of the top management of the organization
2. The first criterion (C1): liberalizing the competitive environment

Table 22: Weight and final rank of sub-criteria of market orientation

Rank	Definite weight	Fuzzy weight	Code	Criterion
4	0.119	(0.115, 0.146, 0.165)	C1	Liberalizing the competitive environment
3	0.281	(0.276, 0.398, 0.216)	C2	Accurate marketing plan
2	0.416	(0.310, 0.587, 0.428)	C3	Approach the customer and make a connection
1	0.522	(0.454, 0.733, 0.659)	C4	Commitment of the top management of the organization

4.5.3 Customer sub-criteria

Determine the most important and least important indicators

1. The fifth criterion (C5): design of products based on customer needs based on greed and size
2. The first criterion (C1): the knowledge and awareness of customers about food

4.6 The main criteria of consequences and results of design a model for the success of NPD with a WCM approach

Determine the most important and least important indicators

1. The third criterion (C3): financial consequences
2. The first criterion (C1: the market development and strengthening the position of food industry

Table 23: Weight and final rank of customer sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
6	0.108	(0.115,0.142,0.110)	C1	The knowledge and awareness of customers about food
5	0.197	(0.250,0.233,0.204)	C2	The importance of providing information to customers about the properties of each food
4	0.228	(0.327,0.276,0.214)	C3	Increase customer options
2	0.458	(0.635,0.527,0.533)	C4	Observe the demands and expectations of customers
1	0.478	(0.548,0.511,0.790)	C5	Design of products based on customer needs based on greed and size
3	0.321	(0.467,0.380,0.319)	C6	Design of products suitable for the tastes of each region

Table 24: Weight and final rank of customer sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
3	0.157	(0.228, 0.156, 0.190)	C1	The market development and strengthening the position of food industry
2	0.369	(0.469, 0.375, 0.622)	C2	Increase customer satisfaction
1	0.543	(0.546, 0.760, 0.437)	C3	Financial consequences

4.6.1 Sub-criteria for market development and strengthening the position of food industry

Determine the most important and least important indicators

1. The second criterion (C2): create a competitive advantage
2. The fifth criterion (C5): the possibility of attracting new customers

Table 25: Weight and final rank of market development and strengthening the position of food industry sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
4	0.265	(0.310, 0.376, 0.154)	C1	Create behavioral tendencies in customers
1	0.511	(0.634, 0.578, 0.700)	C2	Create a competitive advantage
2	0.361	(0.599, 0.380, 0.429)	C3	Access to new markets
3	0.355	(0.530, 0.429, 0.318)	C4	Global product development
5	0.097	(0.098, 0.114, 0.145)	C5	The possibility of attracting new customers

4.6.2 Sub-criteria for increase customer satisfaction

Determine the most important and least important indicators

1. The second criterion (C2): increase customer satisfaction
2. The third criterion (C3): decrease customer costs

Table 26: Weight and final rank of market development and strengthening the position of food industry sub-criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
3	0.176	(0.540,0.135,0.113)	C1	Improve the quality and quantity of food products
1	0.440	(0.643,0.537,0.390)	C2	Increase customer satisfaction
4	0.123	(0.113,0.152,0.174)	C3	Decrease customer costs
2	0.418	(0.326,0.565,0.490)	C4	Increase customer health with organic foods and packaging

4.6.3 Financial consequences sub-criteria

Determine the most important and least important indicators

1. The second criterion (C2): high return on investments
2. The fourth criterion (C4): decrease marketing costs

Table 27: Weight and final ranking of financial consequences criteria

Rank	Definite weight	Fuzzy weight	Code	Criterion
3	0.173	(0.156, 0.243, 0.153)	C1	Sell more products
1	0.514	(0.415, 0.645, 0.735)	C2	High return on investment
2	0.320	(0.546, 0.389, 0.211)	C3	Decrease manufacturing costs
4	0.125	(0.128, 0.176, 0.094)	C4	Decrease marketing costs

5 Conclusions and Suggestions

The purpose of the present study was to rank the success of NPD with a WCM approach in the food industry using the fuzzy BWM method. The results of data analysis have shown that in terms of underlying conditions (c2 and c1), causal (c2 and c3), intervention (c1 and c3), the main category (c1 and c3), strategies (c3 and c1), and consequences related to the success of NPD with WCM approach (c1 and c3) have been the most important and least important indicators. Also, the results of domestic and foreign researches show that no similar research has not been conducted under the title of normal ranking of success of NPD with WCM approach in the food industry using fuzzy BWM method in the domestic home and foreign. The research done in this field is partial, and each of the variables has been examined individually, or the two variables of NPD and WCM have been examined together. In a similar study, Shum and Lin [27] identified appropriate strategies, market orientation, resources and drivers, and partner organizations in general as factors for product success globally. In this study, appropriate strategies, market orientation are introduced as causal factors of the success with a WCM approach. In other research, Sbernini et al. [25] have examined the factors underlying global product development and considered factors such as knowledge and technology, benefiting from government policies, outsourcing, and rapid and flexible access to resources as background factors of the success of the product globally. It is noteworthy in some research, the science and technology [1, 9, 10, 29], and benefiting from government policies and outsourcing [8, 20] have been considered as factors in the success of product development. Cooper and Kleinschmidt [2]; And de Brentani and Kleinschmidt [4] consider the discussion of organizational culture as an underlying factor in the development of products at the global level, which has been suggested as a background factor in this research. According to the results of food industry research, they can find a target market that is most in line with their knowledge and capabilities and equip their resources and facilities to meet the needs of the target market in order to ultimately satisfy the consumer. Finally, the consequences of these activities should be monitored because, with the consequences, the strengths and weaknesses can be identified, and steps are taken to correct, strengthen and improve them. Finally, it is suggested that food industry managers, using the identified elements of product development success at the global level, using the model presented in this study, to examine the gap between the desired situation and the current situation of customer characteristics in product development with a WCM approach and then take the necessary steps to remove barriers and damage so that they can achieve the ultimate goal of successful product development with a WCM approach.

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