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Identification and Management of the Main Challenges in Saffron Industry in Iran

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Abstract

Saffron, as one of the most expensive agricultural product around the world, has an important place among Iran's non-oil exports. Therefore, it is important to solve the problems in Iran's saffron industry as the world's largest saffron producer. Thus, this study attempts to identify the challenges that directly and indirectly affect the saffron industry and cause stagnation. The challenges have been identified and ranked considering the cause-effect relationships between these challenges and the experts' opinion in this field using Interpretive Structural Modeling (ISM). The results of the study show that the absence of the plan of the saffron industry development in the country's budget plan and budget allocation, lack of a holistic and long-term vision and transitional decisions taken by the state managers and policy-makers, multiplicity of policy-making centers and lack of interaction between them are the most important challenges in the saffron industry. Finally, appropriate management strategies have been proposed to help saffron industry achieve stable conditions.

Introduction

Saffron is a plant indigenous to Iran and an important product in agricultural sector, particularly in a non-oil industry. Iran, producing 95% of the world's saffron, is the largest exporter of this product. Razavi Khorasan and South Khorasan provinces are major places of saffron cultivation in Iran. More than 350 tons of saffron was produced in Iran in 2015 which is about 70 tons more than the amount produced in 2014 (National Network of Research and Technology of Medicinal Plants, 2016). Spain, France, India, Germany, Italy and Persian Gulf countries are currently the main markets of Iranian saffron (Ghorbani, 2008). Saffron is mainly used in pharmaceutical industry, hygienic and cosmetics industry, which is growing worldwide. However, there has been little research and investment in this field in Iran.

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As the world's largest saffron producer, Iran is supposed to influence not only the pricing of saffron, but on the overall industry. However, it is not the case. Therefore, to gain the real share in the world market, it is urgent to identify the challenges of the saffron industry and manage them appropriately. The challenges include reduced willingness to work in this industry, traditional work force or in other words lack of skilled labor, lack of cultivation, harvesting and processing machinery and equipment, bulk export of saffron and consequently loss of global market share, rise of new competitors in recent years and etc.

Considering that applied researches have not been done in this field, present study aims to determine the main challenges in the saffron industry by analyzing the cause-effect relationships among these factors. Identification of the main challenges through the causal relationships among them can help managers to improve the current situation in accordance with the resource constraints.

In this study, interpretative structural modeling is used to identify the main challenges of the saffron industry considering the cause-effect relationships among variables. In addition, Impact Matrix Cross-Reference Multiplication Applied to a Classification (MICMAC) was used to cluster the challenges of the saffron industry. The structure of the study is as follows: section 2 includes literature review, section 3 introduces ISM, the methodology used in this study is presented in section 4, in section 5, the results are presented and section 6 concludes the study.

Literature Review

Review of Saffron Industry

Iran produces more than 95 percent of the world's saffron and its market share has increased in recent years (Ministry of Agriculture-Jahad, 2015). However, short steps have been taken to develop this industry and to eliminate the problems in it. The production trend in recent years is presented in Table (1) and in Figure (1).

Table 1. Iran's saffron production from 2005 to 2015 (Ministry of Agriculture-Jahad, 2015)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Amount of production (Kilogram)	235743.5	186839.6	230414	37900.2	215065	239244.8	254060.4	261000	311073	280323	350000

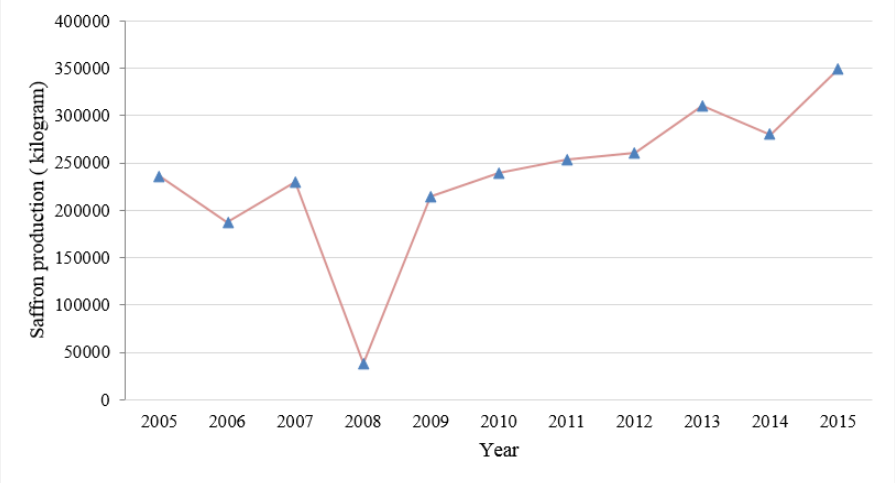

Figure 1. Iran's saffron production from 2005 to 2015 (Ministry of Agriculture-Jahad, 2015)

The amount of the produced saffron, which was, 235743.5 kg in 2005, decreased in 2006. Though, it increased to 230414 kg in 2007, in 2008, because of the drought and frost there was a sudden and sharp decrease in saffron production. Then, 215065 kg saffron was produced in 2009. The production kept growing afterwards, increasing by 11.2, 6.2, 2.7 and 18.9 percent in 2010, 2011, 2012 and 2013 respectively. The production growth was due to the increase in cultivation. Then, 9.9 percent decrease in 2014 was then followed by the highest increase in the decade in 2015 (Ministry of Agriculture-Jahad, 2015). The amount of the export can provide a better insight the saffron industry, The following Table (2) and Figure (2) present the export data from 2001 to 2015.

Table 2. Saffron exported from Iran from 2001 to 2015 (Tehran Chamber of Commerce, Industries, Mines and Agriculture, 2016)

Year	**2001**	**2002**	**2003**	**2004**	**2005**
Export (ton)	121	125	138.9	172	201
Value (US $ million)	51	56	67	95	97
Year	**2006**	**2007**	**2008**	**2009**	**2010**
Export (ton)	140	100	100	65.5	349
Value (US $ million)	76	46	78	179	306
Year	**2011**	**2012**	**2013**	**2014**	**2015**
Export (ton)	211	175	149	97	61
Value (US $ million)	357	408	139	142	81

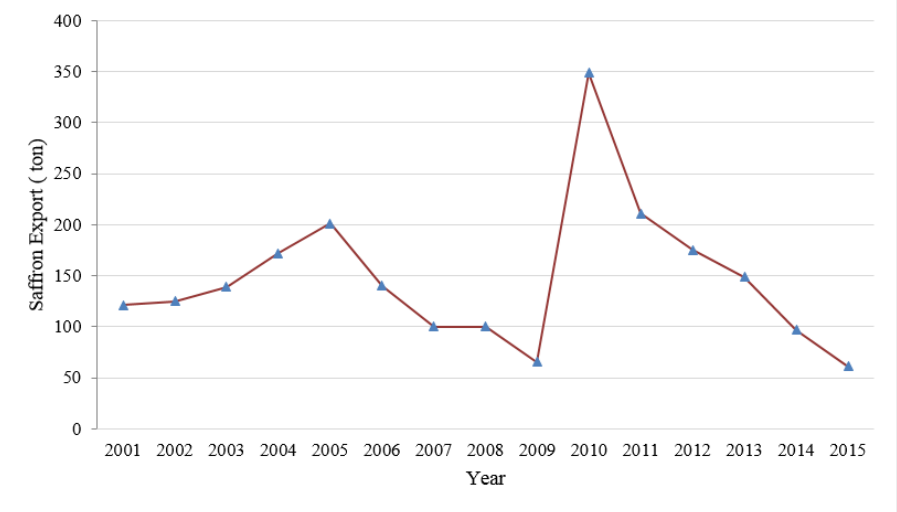

Figure 2. Saffron exported from Iran from 2001 to 2015 (Tehran Chamber of Commerce, Industries, Mines and Agriculture, 2016)

Considering that an increase in non-oil exports is one of the main targets of Iran's development plans, developing saffron industry and increasing its exports can be a positive step in the development of non-oil revenues. The previous studies investigated the the challenges in the saffron industry from the point of view of export and marketing networks and there was no comprehensive study on the industry from different commercial point of views. Therefore, a study on the problems and challenges of this industry is urgent to propose adequate management polices and strategies to overcome the challenges and promote the industry

Ghorbani (2006; 2008) investigated the efficiency of saffron's marketing channel in Iran. Pointing out Iran's 90 percent share of the world's saffron production and export, he calls marketing an important component of saffron industry. The results of the study show that marketing margin is so high in saffron industry that the producers receive less than 65 percent of the final consumer prices. Given the special advantage of saffron, a marketing board is proposed to coordinate saffron production, marketing, and exportation.

Pointing out the conditions of saffron industry in Iran and emphasizing the need to retain Iran's current position as the world's largest saffron producer and exporter, Aghdaie et al. (2012) investigate the barriers to saffron exportation from Iran. They used Porter's Diamond Model to identify the barriers. The results of the study showed that the main barriers to saffron exportation from Iran include demand conditions, related and supporting industries, firm strategy, structure and competition, government, and chance. Kheirandish and Gowda (2012) investigated the marketing efficiency and price expansion for Saffron in Iran. They gathered primary data from 50 saffron merchants. Concepts for analyzing the marketing costs, marketing margin and price expansion and Shepherd's Index were used to compute marketing efficiency. The results of the study show that there is a considerable potential of increasing the producer's share of consumer price if the number of intermediaries is reduced and the government intervenes to organize the marketing network.

In another study about saffron, Aghdaie and Roshan (2015) stated that although Iran is the world's largest saffron producer, due to the barriers to production, advertisement, and exportation, it does not have a main role in saffron pricing. Then commercial barriers to saffron industry and their solutions are presented. Effective factors on increasing saffron exportation included advertisements, proper packaging, customization, attention to the needs and preferences in world market, appropriate pricing strategies, public and specific training, rising public awareness about saffron properties and benefits, as well as making exporters familiar with world market.

Nazemi (2016) Investigated factors affecting the export of pistachio, saffron and solutions in order to improve current situation. The development of non-oil exports as a necessity, guarantee the implementation of economic development programs. In order to investigate the factors affecting export of pistachio and saffron, field study method through questionnaires was used.

In another study, Karbasi and Mohammadzadeh (2016) proposed a strategic framework to identify strengths, weaknesses, opportunities, and threats in the saffron market in Iran. The information was acquired through interviews and questionnaires completed by administrators, experts, manufacturers and exporters of saffron in Qaen county over the course of 2012-2013. Proposed strategies include: the protection and place

strategies; the strategy for the recognition of saffron as an Iranian brand; product quality improvement; a database of knowledge and experience in the field of saffron market; innovation to suit the taste of customers.

In order to implement e-commerce, Hosseini et al. (2016) investigated challenges and solutions for implementing e-commerce in saffron export in Iran. A questionnaire was designed as a data-gathering instrument. The results showed that the most important challenges from social dimension was lack of awareness of the condition and structure of foreign markets, and the most important challenges from legal dimension was lack of protection of the exporter rights, from technical dimension was low Internet speed and lack of network equipment for Internet access.

These studies mainly focused on exportation or marketing. This highlights the importance of a comprehensive study about saffron industry to find the roots of the problems and to propose appropriate strategies to improve current conditions. Therefore, the main goal of the current study is to specify the challenges in respect to exportation, marketing, structure, policy and economy..

Empirical Review of Interpretative Structural Modeling

Increasing the number of factors and the interactions between them is one of the problems that may occur while dealing with complicated systems or issues. In fact, the presence of direct and indirect factors complicates the structure of a system, which is clearly stated. Interpretive Structural Modeling (ISM) is a verified method for identifying the relationships between certain components that define a problem. ISM starts with identifying variables related to a problem or issue. After that, a contextually relevant subordinate relation is selected. After selecting the contextual relation, a structural self-interaction matrix (SSIM) is made based on pair-wise comparison of the variables. After this, SSIM is transformed into a reachability matrix (RM) and its transitivity is controlled. After the transitivity embedding gets completed, a matrix model is achieved. Then, the partitioning of the elements and a structural model called ISM is derived (Attri et al., 2013).

In their study, Alawamleh and Popplewell (2011) investigated the risk in virtual organizations. Thirteen risks related to virtual organizations were identified and the relationships between them were analyzed through data gathered via a questionnaire. Ansari et al. (2013) used ISM in order to develop a structural model of implementing solar power installations in India. Thirteen barriers to implement solar power installations were derived from the literature and through interviews with experts. The relationships between them were determined and MICMAC analysis was used to perform the classification of barriers according to dependence and driving power. A better understanding of these barriers helps the government and the organizations to manage and eliminate the barriers. Using ISM, Govnidan et al. (2013) analyzed managerial strategies of green supply chain in power industry in Brazil. Using dependence power and driving power among managerial methods and considering their compatibility with power industry, the study revealed that cooperation with the customers is a vital strategy among the other ones.

Wu et al. (2015) evaluated risk of offshore pipeline project in Taiwan by using integrated ISM and Bayesian network method. They used ISM to specify an engineering risk factor relationship represented by a cause–effect diagram, which forms the structure of the BN. The results showed that the Bayesian

network can provide explicit risk information to support better project management. Using ISM and fuzzy network analytical process (FNAP) based on investigation and interviews with managers and experts from Iran Khodro industrial group, Valmohammadi and Dashti (2016) specified and rated barriers to e-commerce. The results of their study showed that ignorance of advantages and nature of e-commerce is the main barrier to the implementation of e-commerce.

Hussain et al. (2016) proposed an interpretive structural modeling-analytic network process integrated framework for evaluating potential alternatives for sustainable supply chain management. Various enablers of sustainability in economic, environmental and social dimensions were the criteria used in evaluation. The results of the research revealed that state laws, rewards and focusing on consumers' opinions are the main enablers in the sustainability of supply chain. Shen et al. (2016) presented an identification and analysis on the factors affecting the implementation of Emission Trading System in the building sector in China. They identified fifteen representative factors. These factors have been classified into four categories: autonomous factors, dependent factors, linkage factors, and driving factors.

In the supply chain management, Shibin et al. (2016) built a theoretical framework of the enablers and barriers of flexible green supply chain management (FGSCM). In the study illustrated both the enablers and barriers and their complex interrelationships that impact the design and implementation of flexible and green strategies in a supply chain closed loop system. Ten enablers and eight barriers of FGSCM are identified through an extensive literature review process. Separate frameworks are developed and proposed regarding the enablers and barriers of FGSCM by using total interpretive structural modeling approach. Rajesh (2017) implemented a relational analysis using total interpretive structural modeling (TISM) for technological capabilities and supply chain resilience of firms. before to take decision on implementation of supply chain risk management measures, companies need to identity their technological capabilities and their impacts on supply chain resilience. The result of case study showed that the most influential technological capabilities are capability to modify supply chain design and planning capabilities.

Kumar and Kumar (2017) applied interpretive structural modeling to examine the relationship among the various barriers affecting implementing of lean manufacturing in Indian industry. Indian manufacturing company's efforts is to adopt lean manufacturing practices to satisfy their customers. Therefore, the barriers must be examined and corrective solutions should be proposed to implement lean manufacturing to achieve its full benefit. The results show a way to formulate the strategy to reduce the adverse impact of barriers in lean manufacturing implementation. In addition, Khan et al. (2017), identified the barriers to green and traditional technology transfer (GTTT) based on available literature using a total interpretive structural modeling. The model presented in the study may help understand not only the barriers to technology transfer (TT) but also the relationship among them in terms of driving and dependence powers.

In another study, Chauhan et al. (2017), explored the risk factors affecting new product development (NPD) processes in manufacturing enterprises using ISM. The results of the study revealed the underlying relations between various risk factors prevalent in NPD process. The finding is useful for identifying the driving risk factors they having major impact on product

development process, enabling the decision makers to make proper choices while managing NPD projects. In order to analysis of impediments to sustainability in the food supply chains (FSCs), Darbari et al. (2018) classified most dominant barriers from the suggested barrier list using interpretive structural modeling (ISM). The outcome of ISM has been taken as an input for MICMAC analysis, which classifies the barriers based on their driving and dependence power. The proposed method can be used by decision-makers to overcome the barriers and develop strategies toward incorporation of sustainability in food industry.

Interpretive Structural Modeling Technique

Interpretive Structural modeling (ISM) technique analyzes the relationships between indicators by analyzing the criteria in a few different levels and can be used to analyze the cause-effect relationships between the characteristics of a number of variables defined for one problem (Warfield, 1974; Kannan et al., 2008). In fact, this eight-step method is one system analysis method that investigates the interactions between components of a system. The stepwise process of this method is as follows (Govindan et al., 2010). In the first step, criteria and variables for the issue under consideration (saffron industry in this case) are identified. In the second step, using the criteria and variables identified in the first step, considering every pair of variables and expert opinions, a contextual relation among them is developed based on managerial methods including brainstorming. In fact, experts are asked to comment on the existence of a relation between each pair of variables.

Contextual relation is a conceptual connection between the components of a system in a way that is in accordance with the aims of the system in respect of meaning and content (Warfield, 1974). Symbols used in rankings are as follows:

- V represents the effect of *i* only on *j*
- A represents the effect of *j* only on *i*
- X represents interaction between variables *i* and *j*
- O represents no relation between variables *i* and *j*.

In the third step, a structural self-interaction matrix (SSIM) is developed for variables, which shows pair-wise relationships between the variables. Then, the SSIM is converted into a 0-1- matrix which is the initial reachability matrix. There are just the digits 1 and 0 that indicate direct relations. The rules for the substitution of 0 and 1 with initial symbols are as follows:

- If the *(i,j)* entry in the SSIM is V, then the *(i,j)* entry in the reachability matrix becomes 1 and the *(j,i)* entry becomes 0.
- If the *(i,j)* entry in the SSIM is A, then the *(i,j)* entry in the matrix becomes 0 and the *(j,i)* entry becomes 1.
- If the *(i,j)* entry in the SSIM is X, then the *(i,j)* entry in the matrix becomes 1 and the *(j,i)* entry also becomes 1.
- If the *(i,j)* entry in the SSIM is O, then the *(i,j)* entry in the matrix becomes 0 and the *(j, i)* entry also becomes 0.

In the fourth step, the reachability matrix is developed from the SSIM and becomes the final reachability matrix that considers direct and indirect relations. In fact, this matrix is checked for transitivity. The transitivity of the contextual relation is a basic assumption in ISM. Transitivity says that if a variable A is related to B and B is related to C, then A is necessarily related to C. To achieve the final reachability matrix, the following equations can be used (Warfield, 1974)

$$M = D + I, \quad (1)$$

$$M^* = M^k = M^{k+1}, k > 1 \quad (2)$$

In these equations, D indicates initial reachability matrix, I indicates identity

matrix, K is a positive number bigger than 1, and M^* is the final reachability matrix.

In the fifth step, using reachability and antecedent sets, the reachability matrix calculated in step 4 is classified into different levels. The reachability set shows the variables which are under the influence of one variable. In other words, those criteria in the row related to a variable in front of which there is the digit 1, are the reachability set for that row criterion. Unlike this, the antecedent set of a variable consists of variables which end with that variable or affect it. In other words, those criteria in the column related to a variable in front of which there is the digit 1, are the antecedent set for that column criterion.

Finally, after formulating the reachability set and the antecedent set for each variable and formulating an intersection set (intersection of two sets), variables are partitioned into different levels. Those variables (challenges in saffron industry) whose intersection sets are the same as their reachability sets, occupy the top level. After removing these variables and repeating the same process for the other variables, the levels of the variables will be found out. In the sixth step, based on the relations determined in the reachability matrix, a directed graph is drawn and the transitive relations are removed. In the seventh step, final diagram converted into an ISM by replacing nodes with the names of variables or criteria. In the eighth step, the ISM model developed in step 7 is reviewed to check for conceptual inconsistency. Necessary modifications are made in case of any inconsistency.

Methodology

Regarding its purpose, the present study is empirical and developmental in its nature. Library research and survey were conducted in order to gather necessary data. In addition, the data collection instrument was a questionnaire through which conceptual relations between factors are reviewed. Managers and experts in saffron industry and saffron exportation, experts from Ministry of Agriculture-Jahad and Ministry of Industry, Mine and Trade, and university professors in this field were the statistical population. A sample of 10 people was selected by judgmental (non-random) sampling. The method used is that at the beginning of the research, previous studies about saffron industry were reviewed and a list of the industry's challenges is derived. Afterward, the experts were provided with a list of factors, and the conceptual relations between factors were tried to be investigated using brainstorming technique. Then, using the results obtained, initial reachability matrix and final reachability matrix were respectively developed. In general, the challenges in the saffron industry are partitioned into different levels through eight steps of ISM (Figure 3).

Finally, MICMAC (Impact Matrix Cross-Reference Multiplication Applied to a Classification) is used to categorize factors. To do this, driving power and dependence power should be calculated for each factor in the final reachability matrix. Driving power of a factor is the number of factors which are under the effect of that factor. Dependence power is the number of factors affecting one factor and making it reachable.

According to their driving and dependence powers, factors can be categorized into four categories, i.e. autonomous, dependent, linkage, and independent or driving factors. The aim of this method is to analyze driving and dependence power of variables (Mathiyazhagan et al., 2013). Next, the aforementioned process will be performed to obtain a basic structure of challenges of saffron industry.

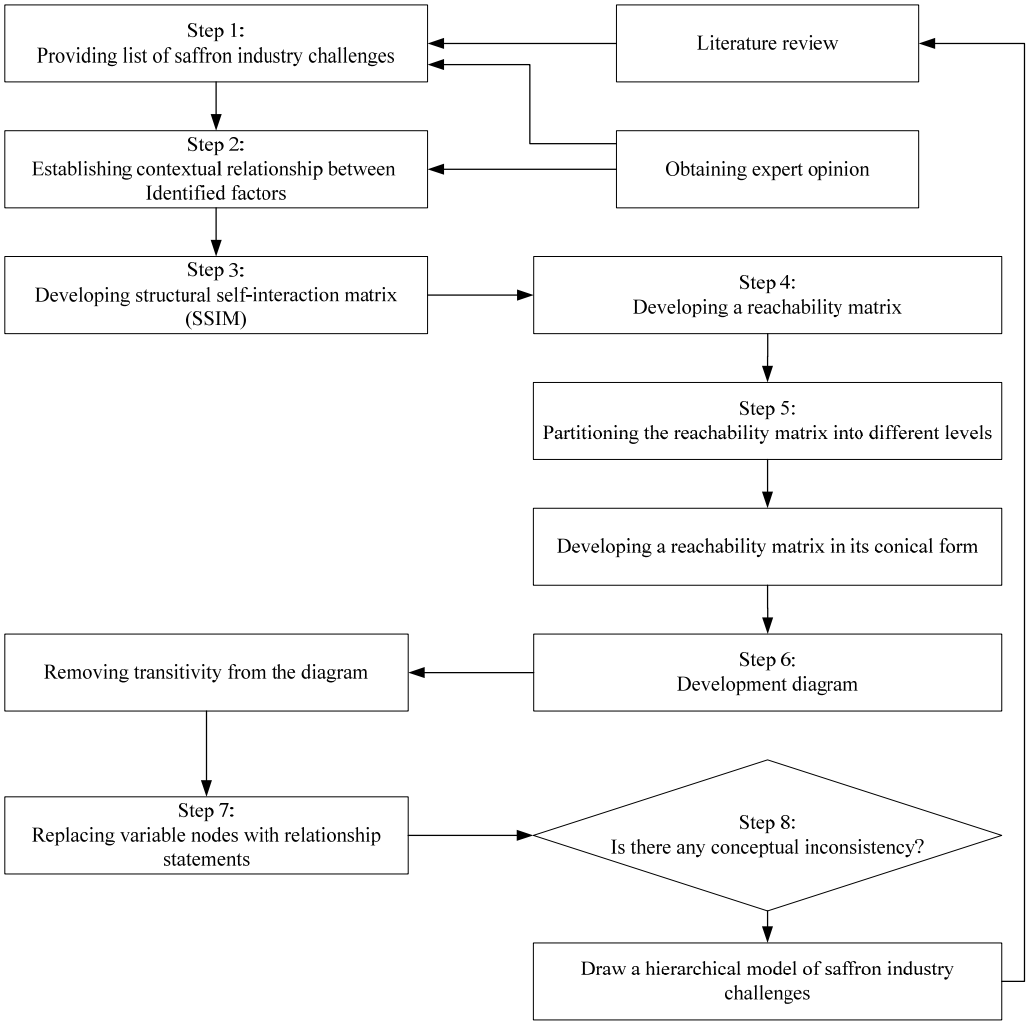

Figure 3. ISM procedure used in this study

The Results of the Analysis

This study has attempted to find out the challenges in the saffron industry and to cluster them. As mentioned before, in the first step of ISM, the challenges in the saffron industry are identified through literature review. After that, the initial list is modified (i.e. adding and removing factors, modification of factor names, combination of factors and further explanations) and considered as the input for ISM. Nineteen factors identified are presented in Table (3). Now, in the second step, based on experts' opinions and using the symbols V, A, X, and O, a contextual relation between challenges of saffron is defined. The resulting matrix is called a structural self-interaction matrix (SSIM) which is presented in Table (4).

Afterward, the structural self-interaction matrix (SSIM) is developed for variables, which shows pairwise relationships between the variables. Then, based on the principle of substituting the four primary symbols with 0 and 1, the SSIM is converted into a 0-1 matrix or the initial reachability matrix. There are just the digits 1 and zero that indicate direct relations. The initial reachability matrix for factors is presented in Table (5).

Table 3. Identified challenges of saffron industry

Symbol	Challenge
C_1	Absence of attention to saffron industry in the country's development and budget plans
C_2	Negative propaganda against Iran and negative attitude toward it in some countries
C_3	Farmers' bad financial situation and inadequate governmental support
C_4	Lack of an integrated local and foreign marketing structure and modern marketing methods
C_5	Shortage of proficient and trained personnel in saffron industry
C_6	Lack of a holistic and long-term view and transitional decisions taken by state managers and policy-making institutions
C_7	Exporting in big packages and in bulk
C_8	Lack of a single national and international standard of production, processing, and packaging
C_9	Absence of Iran in determining the world price of saffron and lack of popularity as the world's largest producer of saffron
C_{10}	Lack of saffron pricing strategy and price fluctuations
C_{11}	Emergence of new competitors
C_{12}	Reluctance of private sector to invest in this industry
C_{13}	Inadequacy of side products of saffron
C_{14}	Failure to control saffron smuggling, saffron brokers and market intermediaries
C_{15}	Failure to comply with the technical and hygienic principles and guidelines from harvest to packaging, and the subsequent quality deterioration
C_{16}	Lack of advanced and equipped laboratories for product quality control
C_{17}	Exporters' unawareness of the target markets and the needs of these markets
C_{18}	Adulterations in saffron production and processing, and public distrust of local producers
C_{19}	Multiplicity of policy-making centers and lack of interaction between them

Table 4. Structural self-interaction matrix (SSIM)

Challenge	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}
C_1	-	O	V	O	O	X	O	V	V	V	O	V	O	O	O	O	O	O	X
C_2		-	O	O	O	O	O	A	V	O	X	O	O	A	A	A	O	O	O
C_3			-	O	O	A	O	O	A	A	O	A	A	A	V	O	O	O	O
C_4				-	O	A	V	O	V	V	V	V	O	V	O	O	V	O	A
C_5					-	O	O	O	O	O	V	X	V	O	V	V	O	V	O
C_6						-	O	V	O	V	O	V	O	V	O	O	O	O	X
C_7							-	O	X	O	V	O	A	A	V	O	A	O	O
C_8								-	V	O	V	O	O	O	V	O	O	V	O
C_9									-	O	X	O	O	O	O	O	V	O	A
C_{10}										-	V	O	O	O	O	O	O	O	A
C_{11}											-	O	O	O	A	O	O	A	O
C_{12}												-	V	O	O	V	O	A	O
C_{13}													-	O	O	O	O	O	O
C_{14}														-	O	O	O	V	A
C_{15}															-	O	O	O	O
C_{16}																-	O	V	O
C_{17}																	-	O	O
C_{18}																		-	O
C_{19}																			-

Table 5. Initial reachability matrix

Challenge	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}
C_1	0	0	1	0	0	1	0	1	1	1	0	1	0	0	0	0	0	0	1
C_2	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
C_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
C_4	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	1	0	0
C_5	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	0	1	0
C_6	1	0	1	1	0	0	0	1	0	1	0	1	0	1	0	0	0	0	1
C_7	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0
C_8	0	1	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0
C_9	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0
C_{10}	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
C_{11}	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C_{12}	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0
C_{13}	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
C_{14}	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
C_{15}	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
C_{16}	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
C_{17}	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
C_{18}	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
C_{19}	1	0	0	1	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0

As stated before, the initial reachability matrix only considers direct relations. On the other hand, it is the final reachability matrix that considers indirect relations as well as the direct ones, so that in Table (6), if factor 1 affects factor 2, and factor 2 affects factor 3, then factor 1 will surely affect factor 3 indirectly. Using the final reachability matrix, driving power (the extent of effect each factor has on other factors) and dependence power (the extent of effect each factor receives from other factors) can be calculated according to the above table.

Then, the final reachability matrix is obtained, which is partitioned into different levels using reachability and antecedent sets for each factor. Following, the variables are partitioned. Those variables whose intersection sets are the same as their reachability sets, occupy the top level. After removing these variables and repeating the same process for the other variables, the levels of the variables are determined. Rankings of the challenges in the saffron industry were done in six iterations. The first and the second iterations are presented in Tables (7) and (8).

Conclusion of the results of the six iterations is presented in Table (9). This table indicates the ranking of challenges of saffron industry. The results are also shown in Figure (4) as an ISM model. According to Figure (4), the factor "Absence of attention to saffron industry in the country's development and budget plans", "lack of a holistic and long-term view and transitional decisions taken by state managers and policy-making institutions", "multiplicity of policy-making centers and lack of interaction between them" are located at the level 6 (i.e. the lowest level in the structure) and are accounted as the most important challenges of saffron industry. In fact, these factors, in addition to directly affecting saffron industry, influence other challenges of the industry and consequently contribute to its deterioration. In addition, factors 2, 3, 7, 9, 11, 15, and 17 are at the same level (the highest one) and are accounted as the most influenced factors. In other words, these

challenges had no significant effect on the stagnation of saffron industry, but the other factors caused these ones to be effective on saffron industry

Table 6. Final reachability matrix

Challenge	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	Driving power	Rank
C_1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19	1
C_2	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	7	6
C_3	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	7	6
C_4	0	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	0	15	2
C_5	0	1	1	0	1	0	1	0	1	0	1	1	1	0	1	1	1	1	0	12	4
C_6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19	1
C_7	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	7	6
C_8	0	1	1	0	1	0	1	1	1	0	1	1	1	0	1	1	1	1	0	13	3
C_9	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	7	6
C_{10}	0	1	1	0	1	0	1	0	1	1	1	1	1	0	1	1	1	1	0	13	3
C_{11}	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	7	6
C_{12}	0	1	1	0	1	0	1	0	1	0	1	1	1	0	1	1	1	1	0	12	4
C_{13}	0	1	1	0	0	0	1	0	1	0	1	0	1	0	1	0	1	0	0	8	5
C_{14}	0	1	1	0	1	0	1	0	1	0	1	1	1	1	1	1	1	1	0	13	3
C_{15}	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	1	1	0	0	7	6
C_{16}	0	1	1	0	1	0	1	0	1	0	1	1	1	0	1	1	1	1	0	12	4
C_{17}	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	7	6
C_{18}	0	1	1	0	1	0	1	0	1	0	1	1	1	0	1	1	1	1	0	12	4
C_{19}	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19	1
Dependence power	3	19	19	4	11	3	19	4	19	5	19	11	12	5	19	11	19	11	3		
Rank	6	1	1	5	3	6	1	5	1	4	1	3	2	4	1	3	1	3	6		

Table 7. Level partition-iteration 1

Challenge	Reachability set	Antecedent set	Intersection set	Level
1	1 to 19	1, 6, 19	1, 6, 19	-
2	2, 3, 7, 9, 11, 15, 17	1 to 19	2, 3, 7, 9, 11, 15, 17	1
3	2, 3, 7, 9, 11, 15, 17	1 to 19	2, 3, 7, 9, 11, 15, 17	1
4	2, 3, 4, 5, 7, 9 to 18	1, 4, 6, 19	4	-
5	2, 3, 5, 7, 9, 11, 12, 13, 15 to 18	1, 4, 5, 6, 8, 10, 12, 14, 16, 18, 19	5, 12, 16, 18	-
6	1 to 19	1, 6, 19	1, 6, 19	-
7	2, 3, 7, 9, 11, 15, 17	1 to 19	2, 3, 7, 9, 11, 15, 17	1
8	2, 3, 5, 7, 8, 9, 11, 12, 13, 15 to 18	1, 6, 8, 19	8	-
9	2, 3, 7, 9, 11, 15, 17	1 to 19	2, 3, 7, 9, 11, 15, 17	1
10	2, 3, 7, 9 to 13, 15 to18	1, 4, 6, 10, 19	10	-
11	2, 3, 7, 9, 11, 15, 17	1 to 19	2, 3, 7, 9, 11, 15, 17	1
12	2, 3, 5, 7, 9, 11, 12, 13, 15 to 18	1, 4, 5, 6, 8, 10, 12, 14, 16, 18, 19	5, 12, 16, 18	-
13	2, 3, 7, 9, 11, 13, 15, 17	1, 4, 5, 6, 8, 10, 12, 13, 14, 16, 18, 19	13	-
14	2, 3, 5, 7, 9, 11 to 18	1, 4, 6, 14, 19	14	-
15	2, 3, 7, 9, 11, 15, 17	1 to 19	2, 3, 7, 9, 11, 15, 17	1
16	2, 3, 5, 7, 9, 11, 12, 13, 15 to 18	1, 4, 5, 6, 8, 10, 12, 14, 16, 18, 19	5, 12, 16, 18	-
17	2, 3, 7, 9, 11, 15, 17	1 to 19	2, 3, 7, 9, 11, 15, 17	1
18	2, 3, 5, 7, 9, 11, 12, 13, 15 to 18	1, 4, 5, 6, 8, 10, 12, 14, 16, 18, 19	5, 12, 16, 18	-
19	1 to 19	1, 6, 19	1, 6, 19	-

Table 8. Level partition-iteration 2

Challenge	Reachability set	Antecedent set	Intersection set	Level
1	1, 4, 5, 6, 8, 10, 12, 13, 14, 16, 18, 19	1, 6, 19	1, 6, 19	-
4	4, 5, 10, 12, 13, 14, 16, 18	1, 4, 6, 19	4	-
5	5, 12, 13, 16, 18	1, 4, 5, 6, 8, 10, 12, 14, 16, 18, 19	5, 12, 16, 18	-
6	1, 4, 5, 6, 8, 10, 12, 13, 14, 16, 18, 19	1, 6, 19	1, 6, 19	-
8	5, 8, 12, 13, 16, 18	1, 6, 8, 19	8	-
10	5, 10, 12, 13, 16, 18	1, 4, 6, 10, 19	10	-
12	5, 12, 13, 16, 18	1, 4, 5, 6, 8, 10, 12, 14, 16, 18, 19	5, 12, 16, 18	-
13	13	1, 4, 5, 6, 8, 10, 12, 13, 14, 16, 18, 19	13	2
14	5, 12, 13, 14, 16, 18	1, 4, 6, 14, 19	14	-
16	5, 12, 13, 16, 18	1, 4, 5, 6, 8, 10, 12, 14, 16, 18, 19	5, 12, 16, 18	-
18	5, 12, 13, 16, 18	1, 4, 5, 6, 8, 10, 12, 14, 16, 18, 19	5, 12, 16, 18	-
19	1, 4, 5, 6, 8, 10, 12, 13, 14, 16, 18, 19	1, 6, 19	1, 6, 19	-

Table 9. Final list of the the challenges in the saffron industry (level partition)

Level	Symbol	Name of challenge
1	C_2	Negative propaganda against Iran and negative attitude toward Iran in some countries
	C_3	Farmers' bad financial situations and inadequate governmental support
	C_7	Exporting in big packages and in bulk
	C_9	Absence of Iran in determining the world price of saffron and lack of popularity as the world's largest producer of saffron
	C_{11}	Emergence of new competitors
	C_{15}	Failure to comply with the technical and hygienic principles and guidelines from harvest to packaging, and the subsequent quality deterioration
	C_{17}	Exporters' unawareness of target markets and needs of these markets
2	**C_{13}**	Inadequacy of side products of saffron
3	**C_5**	Shortage of proficient and trained personnel in saffron industry
	C_{12}	Reluctance of private sector to invest in this industry
	C_{16}	Lack of advanced and equipped laboratories for product quality control
	C_{18}	Adulterations in saffron production and processing, and public distrust of local producers
4	**C_8**	Lack of a single national and international standard of production, processing, and packaging
	C_{10}	Lack of saffron pricing strategy and price fluctuations
	C_{14}	Failure to control the saffron smuggling, saffron brokers and market intermediaries
5	**C_4**	Lack of an integrated local and foreign marketing structure and modern marketing methods
6	**C_1**	Absence of attention to saffron industry in the country's development and budget plans
	C_6	Lack of a holistic and long-term view and transitional decisions taken by state managers and policy-making institutions
	C_{19}	Multiplicity of policy-making centers and lack of interaction between them

After determining the industry challenges, these factors are clustered by MICMAC technique to improve the results. In Table (6), the driving and dependence power of each factor is presented along with their rankings. Each factor can fall in one of four clusters of MICMAC. First of all, the borders dividing the clusters should be determined.

In this study, borderlines are determined based on the experts' opinions, so that they separate different factors properly in clusters according to Figure (5). First cluster is the autonomous cluster, which has weak driving power and weak dependence power. The second cluster includes dependence factors which have weak driving power, but strong dependence power. The third cluster consists of linkage factors, which have strong driving and strong dependence powers. The fourth cluster includes independent factors, which have strong driving power and weak dependence power. Then, one factor with strong driving power is accounted as key factor and falls in the category of independence or linkage variables

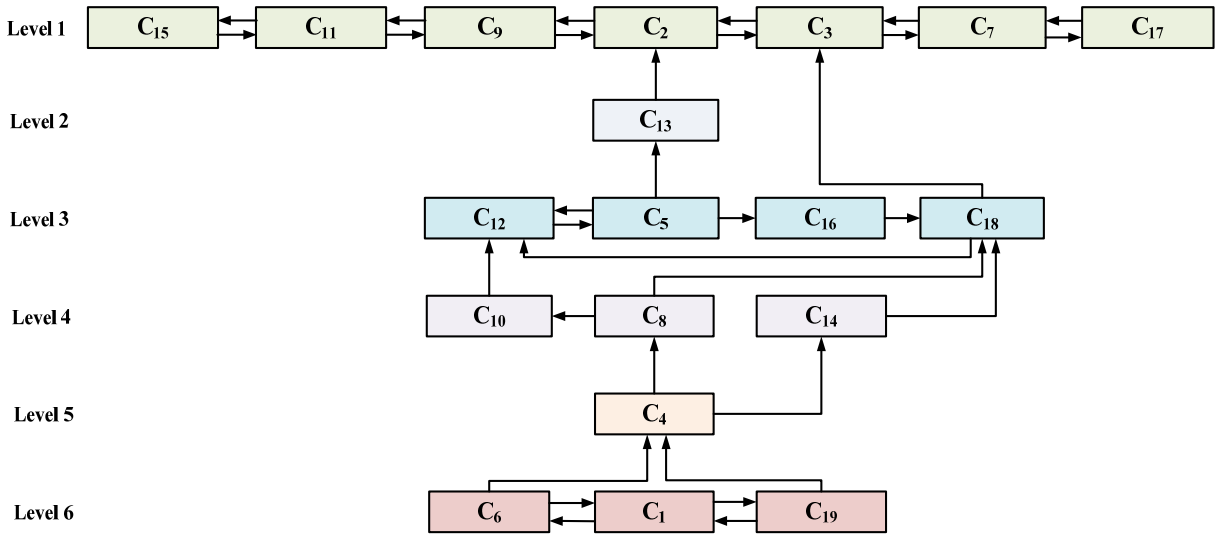

Figure 4. Interpretive structural model drawn for the challenges in the saffron industry

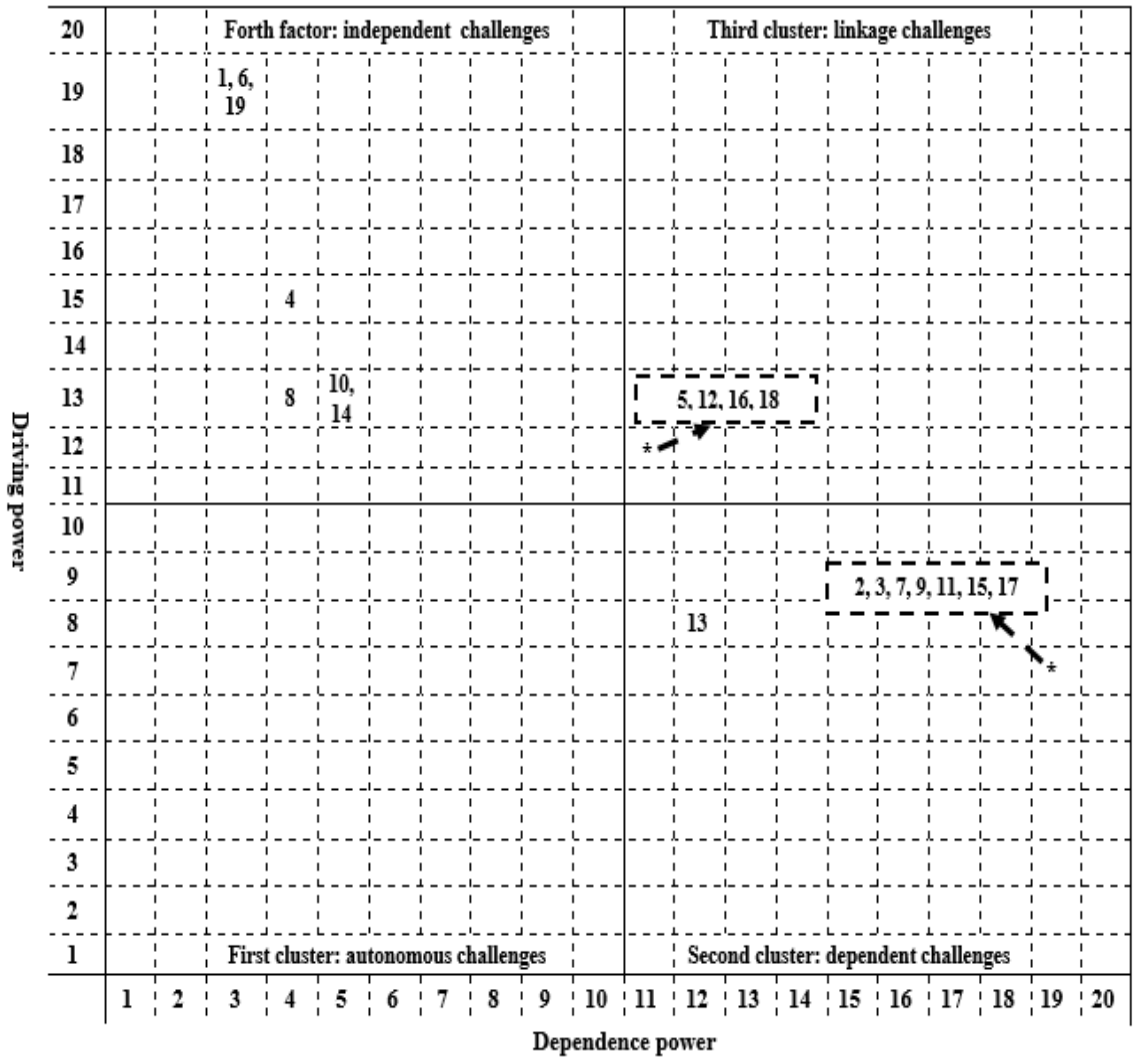

Figure 5. Clustering of the challenges in the saffron industry

As shown in Figure (5), there is no factor having both weak driving power and weak dependence power. Therefore, first cluster (autonomous challenges) does not include any factor. Factors 2, 3, 7, 9, 11, 13, 15, and 17 have weak driving power but strong dependence power, hence they are included in the second cluster (dependent challenges). Factors 5, 12, 16, and 18 are included in the third cluster (linkage challenges) which consists of the factors with strong driving and strong dependence powers.

Factors 1, 4, 6, 8, 10, 14, and 19, i.e. "Absence of attention to saffron industry in the country's development and budget plans", "lack of an integrated local and foreign marketing structure and not using modern marketing methods", "lack of a holistic and long-term view and transitional decisions taken by state managers and policy-making institutions", "lack of a single national and international standard of production, processing, and packaging", "lack of saffron pricing strategy and price fluctuations", "failure to control the saffron smuggling, saffron brokers and market intermediaries", and "multiplicity of policy-making centers and lack of interaction between them" have strong driving power and weak dependence power, hence included in the fourth cluster (autonomous challenges).

These factors are at the lower levels (levels 4, 5, and 6) of ISM and are accounted as the factors affecting current situation. According to the results of the study, factors 1, 6, and 19, which are located in the fourth cluster, are recognized as key factors because they have the highest driving powers. Considering the results of the study a number of strategies are proposed bellow to improve the current situation.

Table 10. Proposed strategies to improve the current situation in saffron industry

Number	Main challenges	Strategy
1	4	Support for human resource training and promoting expertise in marketing and food technology
2	4	Developing a special marketing system to deliver the valuable product to costumers at the lowest cost
3	4	Strengthening the advertising network, so that saffron range of use can be expanded
4	8	Controlling the quality and complying with the standards
5	1	Paving the way for and encouraging the commercialization and internationalization of companies and products by the government
6	1, 6, 8	Pursuing the branding of saffron so that it can be exported under an Iranian brand
7	1, 6, 8, 10, 19	Passing laws and standards for saffron industry by the government
8	1, 6	Setting up R & D centers of saffron industry and allocating funds to them
9	14	Encouraging the formation of large joint-stock companies producing saffron
10	8	Promoting the usage of brands for saffron

Conclusion

Given the importance of saffron industry in Iran, as the world's largest saffron producer, challenges and factors affecting the industry were identified. The needed data were gathered from the literature, experts' opinions, and through investigation of the structure of Iranian saffron market. Unlike other studies focusing on one aspect of the industry, this study, attempted to investigate different aspects of saffron industry and to identify challenges of the industry while considering the interactions between them. The challenges were ranked and clustered using Interpretive Structural Modeling. Identification of the main challenges with regard to the causal relationships between them allows decision maker to choose the most effective corrective solution considering limitations of financial resources and time. The results of the study showed that "Absence of attention to saffron industry in the country's development and budget plans", "lack of an integrated local and foreign marketing structure and modern marketing methods", "lack of a holistic and long-term view and transitional decisions taken by state managers and policy-making institutions", "lack of a single national and international standard of production, processing, and packaging", "lack of saffron pricing strategy and price fluctuations", and "failure to control the saffron smuggling, saffron brokers and market intermediaries" are the main factors affecting saffron industry. Accordingly, proper solutions were proposed to improve the situation.

By investing in the implementation of corrective strategies for the main challenges identified in the saffron industry, the real place of this industry can be gained globally. Due to Iran's superiority in producing saffron in the world, country's policies can have a great influence on the brand identification of saffron with Iran, pricing and export of this product. Increasing the knowledge of saffron processing can also provide the basis for the industrial development of this product. Given the importance of this product in the manufacturing of cosmetic, medical and dyeing products, can provide the basis for export of saffron. The establishment of national standards on the quality of saffron production and its packaging also can attract foreign customers to buy exported products and lead to the development of this industry. In addition, the presence of foreign competitors in the field of non-farm production (packaging of saffron exported in bulk from Iran) and its supply in the global market or exchange of poor quality products, under the name of Iranian saffron in foreign markets, can have a significant impact on exports of Iranian Saffron. Therefore, the need to identify this product as an Iranian brand and preventing the smuggling of this product is becoming more important. Regarding the effect of each solution on improving the current situation, the most effective solutions can be selected based on their cost and implementation time. For this purpose, the use of fuzzy cognitive map method is proposed to measure and prioritize suggested strategies in future researches.

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