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Structural Model of Foresightful Export-Oriented Strategies for Iran Pharmaceutical Industry Using the Fuzzy DEMATEL Method

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Abstract

Background: Export orientation is one of the main approaches in developing the Iranian pharmaceutical industry as a key health-related part of industries. It is necessary to identify, formulate, and implement some foresightful strategies and strategic plans toward adopting the export approach in the Iranian pharmaceutical industry.

Objectives: This paper aimed to identify, prioritize, and develop a structural model of foresightful export-oriented strategies and strategic plans for the Iranian pharmaceutical industry.

Methods: Data gathering for identifying strategies was conducted through literature review and some interviews with pharmaceutical industry experts were analyzed through qualitative content analysis. Afterward, the fuzzy DEMATEL technique was used to prioritize and develop cause and effect and structure the model of identified strategies.

Results: Policy modification, privatization, smart self-sufficiency in production, knowledge management at both national policy and industry firm levels, and quality improvement in all aspects of production and products were identified as foresightful export-oriented strategies and plans for the Iranian pharmaceutical industry.

Conclusion: Privatization is the most effective and important foresightful export-oriented strategy in the Iranian pharmaceutical industry.

Keywords: Foresightful strategies, Fuzzy DEMATEL, Iran pharmaceutical industry, Structure model

1. Background

The studies and reports about the Iranian pharmaceutical industry proposed some challenges and strategies for overcoming barriers and the development of a preferable future. Identified challenges included inadequate policies and investment, pricing system, and technology updating related issues.

There are some potential capabilities for the Iranian pharmaceutical industry (1), and export orientation is one of the most important related indicators (2, 3). Planning some strategies for export-oriented future growth in the Iranian pharmaceutical industry is urgent. Several related strategies are offered for future development, such as new policies adoption (1), pharmaceutical industry-related rule regulation revision (3, 4), enhancement of national and international investment for the export-oriented future formation of Iran pharmaceutical industry, private sector enforcement (3), and obtainment of self-sufficiency (4). Based on challenges and barriers in the Iranian pharmaceutical industry, identification, prioritization, and development of foresightful strategies are the most important goals of this research.

Development of a more competitive environment in the pharmaceutical industry (2), adoption of policies based on branded generics qualitative productions (1, 5), more investment on pharmaceutical infrastructures, revision of regulations for effective role-playing in the international market, boosting pharmaceutical trade and exports (2), the emergence of new private producers (6), and enforcement of the private sector are very important strategies for the future growth of pharmaceutical industry (3). Improvement, technology, and research and development activities provide an appropriate context for the development of the pharmaceutical industry (3). Benchmarking the best practices in the pharmaceutical industry, such as Ireland and Turkey, updating the related rules, and also obtaining self-sufficiency are offered as development strategies in the pharmaceutical industry (4).

There are few former reports and academic studies about the export-oriented foresightful strategies of the Iranian pharmaceutical industry. A review of the related literature indicated that some strategies and strategic development views were mentioned indirectly in articles related to the investigation of the pharmaceutical industry in Iran. Table 1 summarizes the proposed strategies in the literature.

Table 1. Summary of export-oriented foresightful strategies of the Iranian pharmaceutical industry in literature

Strategy	Research
Policy revision	(1, 7, 2, 3, 8, 5, 6, 4)
Investment enhancement	(9, 7, 3, 8, 6, 5)
Empowerment of the private sector	(7, 2, 3, 6)
Self-sufficiency	(4, 10)
Technology and research and development Improvement	(9, 7,3, 5, 11, 4)
Knowledge acquisition	(11)

2. Objectives

The current research aimed to identify, prioritize, and develop a structural model of foresightful export-oriented strategies and strategic plans for the Iranian pharmaceutical industry based on qualitative and quantitative mixed methods using content analysis and group decision-making techniques.

3. Methods

Identification of foresightful strategies in the Iranian pharmaceutical industry was conducted through literature review and interviews with experts based on judgmental sampling. Afterward, the qualitative content analysis method was used to analyze the text of interviews in MAXQDA software (version 2020) to identify the strategies. Moreover, a group decision-making technique as a quantitative method was applied for prioritization and modeling the structure of identified strategies.

In this research, qualitative content analysis was conducted based on instinctive interpretation of the content in text data through the systematic and methodological categorization procedure of coding and recognizing the concepts in patterns or themes. The fuzzy DEMATEL method, as a group decision-making technique, was implemented for prioritizing the strategies and developing the structure model.

3.1. Qualitative content analysis

Qualitative content analysis is a systematic method of analyzing qualitative data, especially in verbal and textual forms (12). This method is used to understand the meaning, concepts, and interpretation of the collected data from interviews, focus groups, discussions, and documents (13).

In this research, the main process of qualitative content analysis method included of questionnaire design based on literature review, experts election based on purposive judgmental sampling, recording the interview, transcription of the interviews, analysis of the text based on a coding system which consisted of interpretation of the interview and obtainment of the experiences and taught of experts, conversion of large texts to concepts and conceptual categories, and also relationships between categories and their similarities to gain the final concepts and codes.

Five well-known experts were selected based on the sampling procedure according to their experiences in the Iranian pharmaceutical industry and related parties as Iran Food and Drugs Association. A Sony recording device was used, and the recorded interviews were converted to text manually. Interpretation and coding were done through MAXQDA software (version 2020).

3.2. Fuzzy DEMATEL

Decision-making trial and evaluation laboratory (DEMATEL) is an effective quantitative multi-criteria decision-making technique that gathers the knowledge of experts, models the inter-relationships among system factors based on a systematic analysis of the quantitative data collected through the pairwise matrix, and indicates the priority, relationship, and structure of factors based on cause-effect relationship diagram.

A fuzzy approach using the linguistic assessment assists the evaluation process to overcome the uncertainties of despondences views by converting precise values to corresponding triangular fuzzy numbers. The fuzzy DEMATEL technique was carried out based on the following steps adopted from a previous study (14).

Step 1: Identification of the decision objectively and forming a committee of experts

A basic literature review is essential to collect information about the decision-making topic, which included foresightful export-oriented strategies of the Iranian pharmaceutical industry. An expert panel should be formed to survey the interaction among each pair of strategies based on a questionnaire.

Step 2: Aggregation of the assessment of experts, provision of the initial direct-relation matrix, and development of the assessment criteria using the fuzzy linguistic scale

Table 2. Correspondence of linguistic terms and linguistic values

Linguistic terms	Corresponding crisp values	Corresponding fuzzy values
Very high effect	4	(0.75, 1.0, 1.0)
High effect	3	(0.5, 0.75, 1.0)
Low effect	2	(0.25, 0.5, 0.75)
Very low effect	1	(0, 0.25, 0.5)
No effect	0	(0, 0, 0.25)

To tackle expert evaluation ambiguities due to judgment according to their experiences and expertise, the lingual judgments turned into crisp and then triangular fuzzy numbers shown in Table 2.

Direct-relation matrix $Z = [z_{ij}]$ was obtained, where Z is an $n \times n$ non-negative matrix, z_{ij} shows the direct effect of strategy i on strategy j. Moreover, when $i = j$, the diagonal elements are zero.

In order to evaluate the relationships between strategies, the decision-making committee of p experts made pairwise comparisons in the form of linguistic terms. Therefore, p fuzzy matrices $\tilde{z}_1, \tilde{z}_2, \dots, \tilde{z}_p$ were derived, each of which represented an expert, and the triangular fuzzy numbers were represented by the entries.

Equation 1 was employed to obtain aggregated mean matrix as below based on fuzzy logic operations.

$$\tilde{Z} = \frac{\tilde{z}_1 \oplus \tilde{z}_2 \oplus \dots \oplus \tilde{z}_p}{p} \quad (Eq\ 1)$$

The fuzzy matrix $\tilde{Z}$ is referred to as the initial direct-relation fuzzy matrix. $\tilde{Z}$ is denoted as

$$\tilde{Z} = \begin{bmatrix} 0 & \tilde{z}_{12} & \cdots & \tilde{z}_{1n} \\ \vdots & & \ddots & \vdots \\ \tilde{z}_{n1} & \tilde{z}_{n2} & \cdots & 0 \end{bmatrix} \quad (Eq\ 2)$$

Here, $\tilde{Z}_{ij} = (l_{ij}, m_{ij}, u_{ij})$ represents triangular fuzzy numbers. Entries $\tilde{Z}_{ij}$ $(i=1,2,\dots,n)$ are referred to as a triangular fuzzy number (0, 0, 0) when needed.

Step 3: Building and analyzing the structural model

Linear scale transformation is employed as a normalization equation to convert the criterion scales into comparable scales. Assume

$$\tilde{a}_{ij} = \sum_{j=1}^{n} \tilde{Z}_{ij} = \left(\sum_{j=1}^{n} l_{ij}, \sum_{j=1}^{n} m_{ij}, \sum_{j=1}^{n} u_{ij} \right)$$

$$and\ r = \max_{1 \le i \le n} \left(\sum_{j=1}^{n} u_{ij} \right) \quad (Eq\ 3)$$

Then, the normalized direct-relation fuzzy matrix is

$$\tilde{X} = \begin{bmatrix} \tilde{x}_{11} & \cdots & \tilde{x}_{1n} \\ \vdots & \ddots & \vdots \\ \tilde{x}_{n1} & \cdots & \tilde{x}_{nn} \end{bmatrix}$$

where $\tilde{x}_{ij} = \frac{\tilde{z}_{ij}}{r} = \left(\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r} \right)$ $(Eq\ 4)$

In order to calculate the total-relation fuzzy matrix $\tilde{T}$

$$\tilde{T} = \begin{bmatrix} \tilde{t}_{11} & \cdots & \tilde{t}_{1n} \\ \vdots & \ddots & \vdots \\ \tilde{t}_{n1} & \cdots & \tilde{t}_{nn} \end{bmatrix}$$

where $\tilde{t}_{ij} = (l''_{ij}, m''_{ij}, u''_{ij})$ $(Eq\ 5)$

$[l''_{ij}] = X_l \times (I - X_l)^{-1}$ $(Eq\ 6)$

$[m''_{ij}] = X_m \times (I - X_m)^{-1}$ $(Eq\ 7)$

$[u''_{ij}] = X_u \times (I - X_u)^{-1}$ $(Eq\ 8)$

Where i is the identity matrix.

Based on $\tilde{T}$, $(\tilde{D}_i + \tilde{R}_i)$ and $(\tilde{D}_i - \tilde{R}_i)$ can be easily calculated, in which $\tilde{D}_i$ and $\tilde{R}_i$ denote the summations of rows and columns of $\tilde{T}$, respectively.

In order to obtain the causal diagram, the Best Non-fuzzy Performance Method (15) was applied for defuzzification.

$$BNP = l + \frac{(u - l) + (m - l)}{3} \quad (Eq\ 9)$$

Next, the causal diagram was built by the horizontal axis $(\tilde{D}_i + \tilde{R}_i)^{def}$ referred to as the “prominence” axis and the vertical axis $(\tilde{D}_i - \tilde{R}_i)^{def}$ referred to as the "relation" axis. The prominence axis represents the degree of the importance of the criterion, while the relation axis can classify the criteria into cause and effect categories. In general, a positive $(\tilde{D}_i - \tilde{R}_i)^{def}$ stands for the cause group, whereas a negative $(\tilde{D}_i - \tilde{R}_i)^{def}$ represents the effect group. Therefore, a causal diagram may provide the visualized model of complex criterion causal relationships, considerably helping solve the problem.

Moreover, the causal diagram helps make appropriate decisions by realizing the differences between the cause and effect criteria. As an organizational strategy, the strategy map indicates the cause-effect relationships. In order to develop a structural model in strategy map, this study identified the assessment criteria of causal relationships through the fuzzy DEMATEL technique using average numbers of $\tilde{t}_{ij} = (l''_{ij}, m''_{ij}, u''_{ij})$ for defuzzification as total relation matrix M. Showing the whole interrelationships between strategies leads to complexity of modeling. Hence, some more significant relationships indicated in the model were based on setting thresholds according to point of view of the researcher (16, 17).

4. Results

Results of analysis in two-phase are presented in this section. Qualitative content analysis and the Fuzzy DEMATEL method were conducted to identify and develop the structural model of foresightful export-oriented strategies for the Iranian pharmaceutical industry.

4.1. Qualitative content analysis

Foresightful strategies of the Iranian pharmaceutical industry were identified based on in-depth literature review and conducting semi-structured interviews with five experts of industry experienced in policymaking as well as governmental and private manufacturing parties.

The questions were planned based on a basic literature review, and the experiences and thoughts of experts helped to deepen the interview data-collection procedure. The interviews lasted from 60 to 90 min and

Table 3. Results of qualitative content analysis

Strategy	Main sub-categories
Policy modification	➢ Management stability in industry and policymaking institutions ➢ Transparency in all procedures ➢ Coordination role-playing of Ministry of Health ➢ Separation of the industry from political activities ➢ Public and governmental sector support for industry development ➢ Modification of the fiscal policy of the government on industry ➢ Facilitation of the entry of new drugs into the list of the pharmaceutical system of the country ➢ Modification of pricing policies and procedures in the Food and Drug Administration ➢ Boost domestic production through new policies
Privatization	➢ Reduction of government ownership in industries ➢ Privatization of the controlling role of the Food and Drug Administration
Smart self-sufficiency in production	➢ Technological development of industry ➢ Movement towards a semi-advanced pharmaceutical economy ➢ Formation of a drug accelerator ➢ Optimization of the production drug portfolio ➢ Production approach based on demographic indicators ➢ Establishment of an industrial clinic in the field of medicine ➢ Development of knowledge-based companies ➢ Development of dedicated production sites
Knowledge management at the national policy level	➢ The need to turn knowledge into a product (commercialization) ➢ Knowledge-based succession planning in industry ➢ Usage of scientific management in industry ➢ Generation of knowledge in science and technology parks ➢ Development of applied research in industry ➢ Acquisition of knowledge from TTAC system ➢ Technology transfer in case of lifting/not lifting sanctions
Knowledge management at manufacturing corporations level	➢ Localization and customization of transferred knowledge and technology ➢ Transferring and sharing knowledge within and among the industries ➢ Participation of scientists in the profits of companies ➢ Acquisition and transferring of tacit knowledge from experts
Quality improvement in all aspects of production and products	➢ Commitment to quality in the pharmaceutical system ➢ The need to strengthen the quality-monitoring system ➢ The need to monitor quality-improvement procedures

were recorded with professional devices and transcribed exactly. The texts were analyzed through MAXQDA software (version 2020) using qualitative content analysis methodology. Whole parts of texts were coded based on related concepts and categorized according to their conceptual relations and similarities. Results of the qualitative content analysis are summarized in Table 3.

Qualitative content analysis indicated that considering the revision of policies, enforcement of private sector, smart and targeted self-sufficiency in production, knowledge management in both national policy and corporations levels, and also quality improvement in whole systems and products are the most important foresightful strategies of the pharmaceutical industry based on the opinions of experts.

4.2. Fuzzy DEMATEL method

Prioritization of identified strategies and developing strategic structural model conducted through fuzzy DEMATEL method. An expert panel consisting of 10 experts was selected purposively who answered the questionnaire. The collected data were analyzed based on the mentioned steps in the fuzzy DEMATEL technique using Microsoft Excel software (version 2016).

The data were collected through pair-wise comparison of questionnaires using linguistic terms. Next, the linguistic terms were converted to crisp and also fuzzy numbers. One expert's answers to the questionnaire indicated crisp and triangular fuzzy numbers form that are summarized in tables 4 and 5, respectively.

Table 4. Assessment data of expert 1 is in crisp numerical form.

	C1	C2	C3	C4	C5	C6
C1	0	2	2	2	2	2
C2	2	0	2	2	2	2
C3	2	2	0	2	2	2
C4	2	2	2	0	2	2
C5	2	2	2	2	0	2
C6	2	2	1	2	2	0

C1: Policy modification, C2: Privatization, C3: Smart self-sufficiency, C4: knowledge management at the national policy level, C5: knowledge management at the corporation level, C6: Quality improvement of all aspects of production and products

Table 5. Assessment data of the first expert in triangular fuzzy form

	C1	C2	C3	C4	C5	C6
C1	0 , 0 , 0	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75
C2	0.25 , 0.5 , 0.75	0 , 0 , 0	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75
C3	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0 , 0 , 0	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75
C4	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0 , 0 , 0	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75
C5	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0 , 0 , 0	0.25 , 0.5 , 0.75
C6	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0 , 0.25 , 0.5	0.25 , 0.5 , 0.75	0.25 , 0.5 , 0.75	0 , 0 , 0

Table 6. Initial direct-relation fuzzy matrix

	C1			C2			C3			C4			C5			C6			Sum of rows
C1	0.00	0.00	0.00	0.45	0.70	0.90	0.40	0.65	0.85	0.43	0.68	0.93	0.43	0.68	0.93	0.45	0.70	0.93	10.08
C2	0.48	0.73	0.90	0.00	0.00	0.00	0.48	0.73	0.93	0.40	0.65	0.88	0.40	0.65	0.88	0.43	0.68	0.88	10.05
C3	0.48	0.73	0.93	0.45	0.70	0.88	0.00	0.00	0.00	0.35	0.60	0.85	0.40	0.65	0.90	0.45	0.70	0.93	9.98
C4	0.38	0.63	0.88	0.33	0.58	0.83	0.43	0.68	0.90	0.00	0.00	0.00	0.35	0.58	0.83	0.45	0.70	0.90	9.40
C5	0.30	0.53	0.78	0.25	0.50	0.75	0.43	0.68	0.90	0.30	0.55	0.80	0.00	0.00	0.00	0.38	0.63	0.88	8.63
C6	0.38	0.63	0.88	0.35	0.60	0.83	0.38	0.63	0.83	0.35	0.60	0.85	0.40	0.65	0.88	0.00	0.00	0.00	9.20
r																			10.08

Table 7. Normalized aggregated data of the 10 experts in triangular fuzzy form

	C1			C2			C3			C4			C5			C6		
C1	0.000	0.000	0.000	0.045	0.069	0.089	0.040	0.065	0.084	0.042	0.067	0.092	0.042	0.067	0.092	0.045	0.069	0.092
C2	0.047	0.072	0.089	0.000	0.000	0.000	0.047	0.072	0.092	0.040	0.065	0.087	0.040	0.065	0.087	0.042	0.067	0.087
C3	0.047	0.072	0.092	0.045	0.069	0.087	0.000	0.000	0.000	0.035	0.060	0.084	0.040	0.065	0.089	0.045	0.069	0.092
C4	0.037	0.062	0.087	0.032	0.057	0.082	0.042	0.067	0.089	0.000	0.000	0.000	0.035	0.057	0.082	0.045	0.069	0.089
C5	0.030	0.052	0.077	0.025	0.050	0.074	0.042	0.067	0.089	0.030	0.055	0.079	0.000	0.000	0.000	0.037	0.062	0.087
C6	0.037	0.062	0.087	0.035	0.060	0.082	0.037	0.062	0.082	0.035	0.060	0.084	0.040	0.065	0.087	0.000	0.000	0.000

Aggregated views of experts calculated using fuzzy numbers operations as shown in Table 6 as the initial direct-relation fuzzy matrix. In order to normalize the matrix, the introduced r calculated and normalized direct-relation fuzzy matrix is indicated in Table 7. Calculation of the total-relation fuzzy matrix $\tilde{T}$ was conducted based on equations 5 to 8 and is proposed in Table 8. $\tilde{D}_i$, $\tilde{R}_i$, $(\tilde{D}_i + \tilde{R}_i)$, and $(\tilde{D}_i - \tilde{R}_i)$ were obtained based on defuzzification of the total relation of fuzzy matrix $\tilde{T}$ and is summarized in Table 9.

Causal diagram derived from $(\tilde{D}_i + \tilde{R}_i)$ values as the prominence central role degree in the horizontal axis and $(\tilde{D}_i - \tilde{R}_i)$ values as the relation degree in the vertical axis are depicted in Figure 1. Structural model of the strategies shown in Figure 2 are derived from the total relation matrix M based on defuzzification of total-relation fuzzy matrix $\tilde{T}$. The appropriate thresholds

Table 8. Calculation of the total-relation fuzzy matrix $\tilde{T}$

$[l''_{ij}]$					
0.010	0.052	0.049	0.050	0.050	0.054
0.055	0.009	0.056	0.048	0.048	0.051
0.055	0.052	0.010	0.043	0.048	0.053
0.045	0.040	0.050	0.008	0.043	0.053
0.037	0.032	0.049	0.036	0.008	0.044
0.045	0.042	0.045	0.042	0.047	0.009
$[m''_{ij}]$					
0.030	0.093	0.091	0.091	0.092	0.096
0.097	0.029	0.098	0.089	0.090	0.094
0.097	0.093	0.031	0.085	0.090	0.096
0.086	0.081	0.091	0.026	0.082	0.094
0.075	0.072	0.089	0.076	0.025	0.085
0.086	0.082	0.087	0.082	0.088	0.029
$[u''_{ij}]$					
0.063	0.142	0.141	0.146	0.147	0.149
0.144	0.059	0.146	0.141	0.142	0.144
0.146	0.140	0.063	0.139	0.145	0.148
0.140	0.134	0.143	0.059	0.136	0.144
0.129	0.124	0.140	0.130	0.058	0.139
0.139	0.133	0.135	0.136	0.140	0.061

Table 9. Calculation of $\tilde{D}_i$ and $\tilde{R}_i$ and $(\tilde{D}_i + \tilde{R}_i)$ and $(\tilde{D}_i - \tilde{R}_i)$

	$\tilde{D}_i$			$\tilde{R}_i$			$(\tilde{D}_i + \tilde{R}_i)$			$(\tilde{D}_i - \tilde{R}_i)$			$(\tilde{D}_i - \tilde{R}_i)^{def}$	$(\tilde{D}_i + \tilde{R}_i)^{def}$
Policy modification	0.788	0.494	0.265	0.760	0.470	0.247	1.548	0.965	0.512	0.788	0.494	0.265	0.023	1.008
Privatization	0.777	0.498	0.268	0.732	0.450	0.226	1.509	0.948	0.494	0.777	0.498	0.268	0.045	0.984
Smart self-sufficiency	0.780	0.491	0.262	0.768	0.487	0.259	1.549	0.979	0.521	0.780	0.491	0.262	0.007	1.016
knowledge management in national level	0.756	0.460	0.238	0.752	0.450	0.226	1.509	0.910	0.464	0.756	0.460	0.238	0.009	0.961
knowledge management in corporations	0.720	0.422	0.205	0.768	0.467	0.244	1.488	0.889	0.449	0.720	0.422	0.205	-0.044	0.942
Quality improvement	0.744	0.453	0.229	0.784	0.494	0.265	1.529	0.948	0.494	0.744	0.453	0.229	-0.039	0.990

were set according to the researcher's perception during research completion steps indicated in Table 10 and threshold suggestion offered in Table 11 in which the thick arrow is drawn from criterion x to criterion y when $Z_{xy} \geq 0.098$, the thin arrow is drawn when $0.095 \leq Z_{xy} < 0.098$, and no arrow is drawn when $Z_{xy} < 0.095$.

Moreover, strategies with dash lines were considered the effect group, and strategies depicted with the line were considered the cause group. Prioritization of strategies was obtained from the integration of 10 questionnaires from expert interviews to evaluate the significance and then calculate the mean values as shown in Table 12.

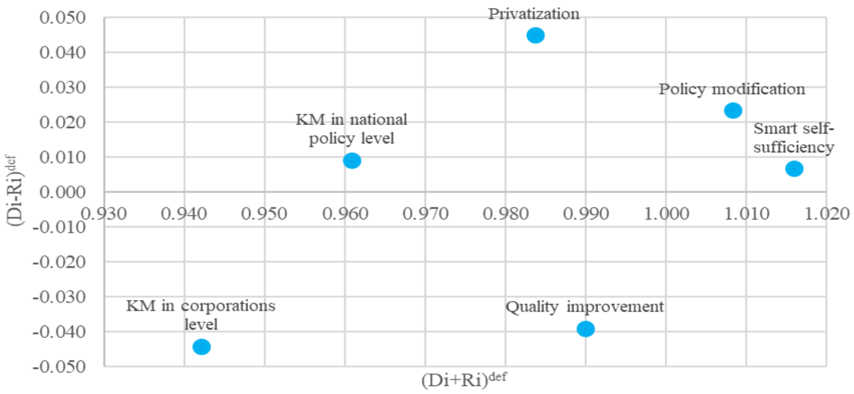

Figure 1. Causal diagram

Table 10. Total relation matrix M

	Policy modification	Privatization	Smart self-sufficiency in production	Knowledge management at the national policy level	Knowledge management at the corporations level	Quality improvement in all aspects of production and products
Policy modification	0.0341	0.0959	0.0938	0.0957	0.0967	0.0995
Privatization	0.0988	0.0326	0.1001	0.0926	0.0937	0.0965
Smart self-sufficiency in production	0.0993	0.0950	0.0346	0.0888	0.0943	0.0992
Knowledge management at the national policy level	0.0904	0.0846	0.0947	0.0314	0.0869	0.0969
Knowledge management at corporation level	0.0801	0.0759	0.0925	0.0807	0.0303	0.0894
Quality improvement in all aspects of production and products	0.0897	0.0855	0.0890	0.0867	0.0914	0.0330

Table 11. Inter-relationships threshold suggestion

Effect intensity	Numerical interval	Counts of interactions
Low	0.095>	25
Moderate	0.095-0.098	6
High	0.098<=	5

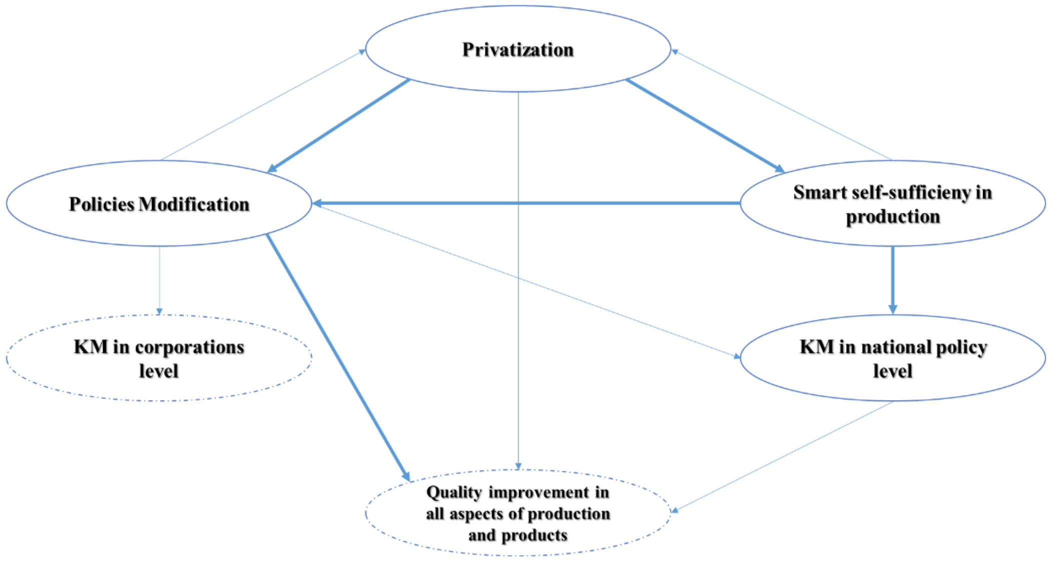

Figure 2. Strategy map as a structural model

Table 12. Evaluation criteria of significance

Strategy	Mean Value	Priority
Privatization	2.2833	1
Policy modification	2.2833	2
Smart self-sufficiency in production	2.2500	3
Knowledge management at the national policy level	2.0833	4
Quality improvement in all aspects of production and products	2.0667	5
Knowledge management at the corporation level	1.9167	6

5. Discussion

As shown in the casual diagram and structural model, privatization, policy modification, smart self-sufficiency in production, and knowledge management at the national policy level were identified as important casual foresightful export-oriented strategies. Furthermore, knowledge management at the corporation level and quality improvement in production was introduced as significantly effective foresightful export-oriented strategies in the Iranian pharmaceutical industry. The high national-level strategies, such as privatization and policy modification, highlighted the importance of change in industry leadership, planning, and control system. Therefore, the reduction of government ownership in the pharmaceutical industry, which is managed above 70% by governmental holdings (e.g., TPICO, Shafa, and Barkat) facilitates the export orientation in the desired future of the industry.

Policy modification is essential for future development, especially in the development of plans, control, and coordination mechanisms as well as macro-financial and economic decisions, including the allocation of foreign currency and Rial financial resources and assistance in the development of the industry. Smart self-sufficiency in production and attention to knowledge management at the macro level of industry policy-making are important in the next positions. The key for creating a preferred future in an export-based industry is to improve the quality of production and products. Knowledge management in these manufacturing industries also provides a suitable platform for knowledge acquisition, optimal utilization of elites, and proper application of knowledge and transfer of technology from successful examples and best practices of domestic and foreign manufacturers.

6. Conclusion

This study aimed to identify, prioritize and develop a causal and structural model of future development strategies of the Iranian pharmaceutical industry based on an export-oriented approach as a strategic health-related industry. In this regard, the opinions and experiences of experts were used in two stages of research. After reviewing the strategies introduced in previous studies and reports, five industry experts were interviewed in the first stage, and the interviews were reviewed by qualitative content analysis. In total, six strategies were identified, including macro-policy reform and modification, privatization, smart self-sufficiency in production, knowledge management at the national policy level, knowledge management at the enterprises level, and finally, quality improvement of all aspects of production and products.

After identification of the mentioned strategies, using the fuzzy DEMATEL method, the structural model, causal diagram, and prioritization of the strategies were obtained and presented. Accordingly, privatization, policy modification, smart self-sufficiency in production, and knowledge management at the national policy level were ranked from one to four as the strategies of the cause group. Moreover, quality improvement in all dimensions of production and products as well as knowledge management at the level of manufacturing companies were ranked fifth and sixth in the group as strategies of the effect group .

According to the results, to achieve a promising future in the pharmaceutical industry of the country based on the export-oriented approach, it is necessary to privatize in the context of reducing the ownership role of government in the production and entrust part of the specialized role of supervision to the private sector. Moreover, reforming macro policies in this area, including infrastructure and financial support for industries, modification of pricing policies, and separation of industries from political lines play an effective role in shaping the desired future of the industry.

Based on the results, some strategies and strategic actions can facilitate the search for a promising future for the industry and improve export development. These factors include attention to knowledge management at both levels of macro policy and manufacturing industries through the transfer of technical knowledge and experiences of successful domestic and foreign examples and the development of related science and technology parks, development of information technology infrastructure based on knowledge generation, and distribution of appropriate use of elite young people and industry experts.

In the meantime, paying attention to quality in all aspects of production, production processes, final products, and raw materials will be effective. Investigation of tactics and actions mentioned in each strategy based on a quantitative study of the relationship and interaction between them can be the basis for further studies.

References

1. Rasekh HR, Mehralian G, Vatankhah-Mohammadabadi AA. Situation analysis of R & d activities: an empirical study in Iranian pharmaceutical companies. *Iran J Pharm Res IJPR*. 2012;**11**(4):1013-1025. doi:10.22037/IJPR.2012.1192.
2. Yusefzadeh H, Rezapour A, Lotfi F, Ebadifard Azar F, Nabilo B, Abolghasem Gorji H, Hadian M, Shahidisadeghi N, Karami A,et al. A Study of Comparative Advantage and Intra-Industry Trade in the Pharmaceutical Industry of Iran. *Glob J Health Sci*. 2015;**7**(6):295-307. doi:10.5539/gjhs.v7n6p295.
3. Shabaninejad H, Madani H, Amineh ZA, Doostzadeh E. A framework for evaluation of pharmaceutical industry development in developing countries: Evidence from Iran. *Asian J Pharm Clin Res*. 2016;**9**(5):50-54. doi: 10.22159/ajpcr.2016.v9i5.10099.
4. Kian MJ, Hadian M, Ghaffari S. Factors affecting pharmaceutical industry enforcements in Iran and selected countries. *Arch Pharm Pract*. 2020;**11**(S4):95-102.
5. Yousefi N, Mehralian G, Rasekh HR, Yousefi M. New product development in the pharmaceutical industry: Evidence from a generic market. *Iran J Pharm Res*. 2017;**16**(2):831-843. doi:10.22037/IJPR.2017.2058.
6. Cheraghali AM. Trends in Iran Pharmaceutical Market. *Iran J Pharm Res IJPR*. 2017;**16**(1):1-7. doi:10.22037/ijpr.2017.2165.
7. Mehralian G, Shabaninejad H. The importance of competitiveness in new internationalized and competitive environment of the pharmaceutical industry. *Iran J Pharm Res*. 2014;**13**(2):351-352. doi:10.22037/IJPR.2014.1519.
8. Varmaghani M, Hashemi-Meshkini A, Abdollahiasl A, et al. An overview to pharmaceutical financing in Iran. *J Pharmacoeconomics Pharm Manag*. 2017;**2**(1/2):45-49.
9. Azbari ME, Olfat L, Amiri M, Soofi JB. A Network Data Envelopment Analysis Model for Supply Chain Performance Evaluation: Real Case of Iranian Pharmaceutical Industry. *Int J Eng Prod Res*. 2014;**25**(2):125-137.
10. Karbassi Yazdi A, Muneeb FM, Wanke PF, Figueiredo O, Mushtaq I. Critical Success Factors for Competitive Advantage in Iranian Pharmaceutical Companies: A Comprehensive MCDM Approach. *Math Probl Eng*. 2021:1-17. doi:10.1155/2021/8846808.
11. Kazemi M, Moghimi SM, Pourezzat AA. Identifying dynamic capabilities in pharmaceutical industry by Grounded theory (GT). *J Futur Manag Res*. 2019;**30**(117):1-11.
12. Schreier M. Qualitative Content Analysis. In: *The SAGE Handbook of Qualitative Data Analysis*. SAGE Publications; 2014:170-184. doi:10.4135/9781446282243.n12.
13. Schilling J. On the pragmatics of qualitative assessment designing the process for content analysis. *Eur J Psychol Assess*. 2006;**22**(1):28-37. doi:10.1027/1015-5759.22.1.28.
14. Chang B, Chang CW, Wu CH. Fuzzy DEMATEL method for developing supplier selection criteria. *Expert Syst Appl*. 2011;**38**(3):1850-1858. doi:10.1016/j.eswa.2010.07.114.
15. Aly S, Vrana I. Evaluating the knowledge, relevance, and experience of expert decision-makers utilizing the Fuzzy-AHP. *Agric Econ*. 2008;**54**(11):529-535. doi:10.17221/264-agricecon.
16. Li CW, Tzeng GH. Identification of a threshold value for the DEMATEL method using the maximum mean de-entropy algorithm to find critical services provided by a semiconductor intellectual property mall. *Expert Syst Appl*. 2009;**36**(6):9891-9898. doi:10.1016/j.eswa.2009.01.073.
17. Mohammadfam I, Mirzaei Aliabadi M, Soltanian AR, Tabibzadeh M, Mahdinia M. Investigating interactions among vital variables affecting situation awareness based on Fuzzy DEMATEL method. *Int J Ind Ergon*. 2019;**74**:102842. doi:10.1016/j.ergon.2019.102842.