



Fuzzy Dynamic Modeling for Export Consortia in Small and Medium-Sized Enterprises

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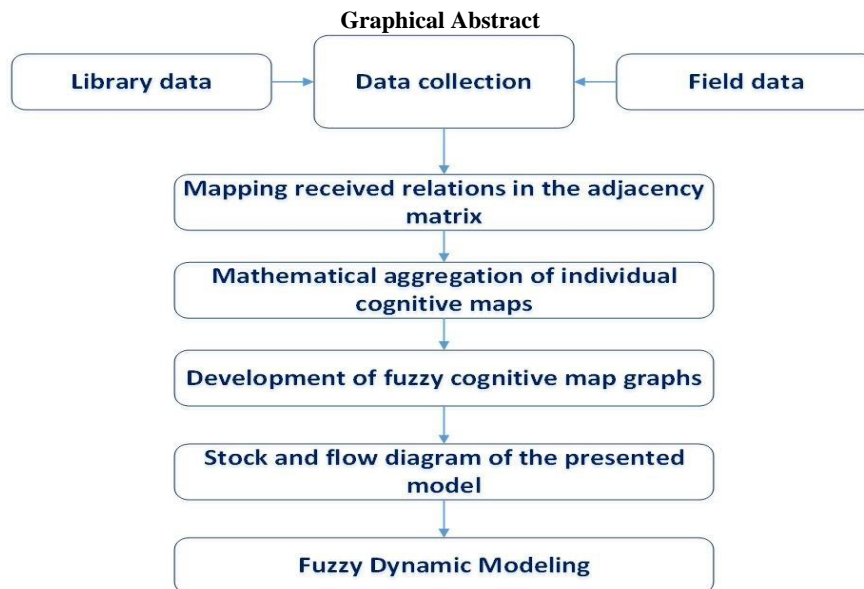
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ABSTRACT

The absence of active export consortia and the lack of a technical, serious, and codified plan for their development are among the most important reasons for Iran's small and medium-sized enterprises (EMSs) remaining in the country's export coordinates. In this study, the data are collected and analyzed with a mixed (qualitative-quantitative) approach, which is a critical paradigm. The data are collected using library research and field methods. In the field section, structured, exploratory, and collaborative interviews are used in the qualitative phase, and the researcher-made questionnaires are used in the quantitative phase. The data are analyzed using grounded theory, brainstorming sessions, fuzzy cognitive map (FCM), fuzzy inference system (FIS), and system dynamics modeling (SDM). According to the results, "features of consortium members", "export operational plan", "consortium strengthening factor", "recognition of export support", "transnational factors", "government factors", and "product features" are the seven main success factors of private sector export consortia in Iranian industries. Furthermore, identifying a suitable promoter, identifying potential members, conducting the desired study and contacting interested companies, appointing representatives, holding meetings between potential members, conducting a feasibility study and preparing a business plan, officially forming a consortium, and following up on consortium affairs are eight steps for establishing private sector export consortiums in Iranian industries.

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1. INTRODUCTION

Small and Medium Enterprises (SME) are one of the most important factors of economic development and their importance in regional economic growth (1). National development in today's world cannot be imagined without considering foreign trade. According to the review of the economic and financial developments of the world after the industrial revolution, the developed countries managed to enhance their political and economic power by using the important and influential part of export. Exports contribute significantly to the development of a country's economy in the present era, and all governments are aware of its economic impact (2). Nowadays, small and medium-sized enterprises (SMEs) have to deal dynamically and innovatively with the challenges caused by the liberalization of trade worldwide and globalization. SMEs have a low export share and low competitiveness to be present in foreign markets, especially in the face of large market powers, due to their small sizes (3, 4).

There are usually problems faced by SMEs in exporting to foreign markets. SMEs may lack the necessary knowledge and financing, fail to meet foreign regulatory requirements, and produce products of inadequate quantity or quality for foreign buyers among many other potential problems (5). Accordingly, they must take measures to survive in this fast-paced movement. Cooperation between SMEs and the formation of export consortia are some of the solutions to these problems (6). SMEs can significantly increase their export potential and reduce the costs and risks of penetrating international markets by combining knowledge, financial resources, and connections in the form of an export consortium. Export consortia provide a wide range of services from basic administrative services to those that improve the production structure in the form of medium-term to long-term strategic cooperation to provide specialized services to facilitate access to foreign markets (7). Lack of proper organizational support, weak judicial and legal systems, non-adherence to written and approved regulations, and increasing costs caused by uncertainty and lack of credibility can be solved by forming consortia (8-11). Service-oriented approaches should prevail, current and emerging markets should be developed, a new organizational system should be adopted, and business networks in the country should be investigated, created, analyzed, and developed due to recent economic developments and to take advantage of their benefits (12). Thus, the export capability of SMEs can be improved and the basis for developing and expanding their activities, generating income, improving the

quantity and quality of products, increasing exports, and reducing unemployment can be provided by a better understanding of the main success factors of SME export consortia and having a conceptual model for their development.

If consortium members pool their resources to acquire equipment, systems, and services (marketing, logistics, training, technical consulting, etc.), economies of scale may emerge. So, as a group, they increase the bargaining power, enabling access to products and services under better conditions. Besides, a common definition should be provided, and "regulations of production" should be developed (to achieve quality certificates representing significant achievements in terms of added value) (13). Continuous information exchange between SMEs (for example, HRM practices) directly contributes to their competitiveness. The results of conventional SME upgrading programs can be enhanced through export consortia because cost reductions, economies of scale, and multiplier effects can significantly increase the number of SMEs benefiting from modernization initiatives (14). Export consortia act as powerful tools to strengthen the relationship between the value chains of member companies and increase competition. Moreover, in an export consortium, strengthening competitive advantages in export markets mainly leads to the expansion of local market share¹. Many countries have promoted consortia and other forms of networks among SMEs due to the importance of networks for the growth and competitiveness of SMEs. The initial network and development of trust between members can be facilitated through public agencies (15). As facilitators, government trade promotion agencies act consciously in helping SMEs, contribute to their goals, and follow a legal nature accordingly. However, the commitment and active participation of the consortium members cannot be replaced by external incentives to establish a consortium. One of the necessary conditions for the emergence and development of effective networks is a positive understanding of the results of network establishment (6).

SMEs form the basis of Iran's economy. Due to their limited activities, SMEs naturally cannot take advantage of the cost-effectiveness of production. Private sector agencies are suitable and reliable platforms for establishing different consortia, both for production and export. However, they have advantages and disadvantages that should be recognized. Although the field research indicates that there are inconsistent examples of export consortia in the leather, furniture, and carpet industries in Iran. These consortia have taken no successful action. Mass production, securing foreign

¹ [www.unido.org\(2005\)](http://www.unido.org(2005))

exchange income, increasing employment, improving quality, and reducing the price of manufactured products are some of the benefits of strengthening export consortia. Appropriate models should be used to take advantage of export consortia in achieving economic growth and development as much as possible. Identifying the success factors of export consortia and how to establish them and designing a scenario-based model in this field to deal with unforeseen changes are some strategies to strengthen export consortia .

Ortega et al. (16) used fuzzy logic and system dynamics (SD) to deal with uncertainties and ambiguities in epidemic problems such as ambiguity in risk factors, contact patterns, and infection conditions and risks. They used Mamdani's max-min inference method for the multiple input multiple output (MIMO) model and the center of area (COA) defuzzification method to calculate the deterministic output (16). In a study by Chang et al. (17), the applications of fuzzy computing in SDM were investigated and the results were evaluated for the recruitment-customer-producer model. In this model, triangular membership functions were used for the variables "order quantity receipt rate" and "labor productivity". However, these fuzzy variables did not interact with each other in the model, and the combination of fuzzy variables was not reflected in the study (17).

In their study, Ghazanfari et al. (18) investigated the applications of fuzzy logic in the dynamics of systems and provided causal loop diagrams (CLDs) with fuzzy relations. In a study by Xu & Li (19), a conceptual model was proposed for initial values and flow and stock variables using SD and fuzzy optimization. FCMs and qualitative relations were used in SD models in a study by Carvalho & Tome (20). In a study by Herrera et al. (21), a combined approach of fuzzy logic and dynamic system modeling was proposed. Reviewing the literature on the use of fuzzy theory in dynamic systems modeling suggests that although dynamic systems modeling tries to better draw uncertain parameters, it sometimes causes problems (22). For example, the soft variables that are mainly based on the subjective opinions of the modeler are shown using lookup functions. So, many applications of fuzzy theory in SD are focused on modeling imprecise fuzzy parameters and variables. However, they lack a comprehensive approach to use fuzzy inference systems (FISs) as decision-making tools in export consortium dynamics. In addition, previous studies have provided no evidence of implementing the FIS output representation in an SD model. The use of SD models in past studies is mainly limited to drawing mathematical formulas. Thus, the principle of SD is not fully covered .

This study can be considered a model for the success of export consortia to help SMEs to enter international markets. Studies can investigate the application of the SD model based on fuzzy logic in private sector export consortia in Iran in subjective, perceptual, and external

aspects, as well as the necessary factors for the success of such consortia and their performance evaluation. In addition, correct decisions can be made in ambiguous fuzzy environments and a comprehensive view can be presented by simultaneously considering the role of all members with a system approach based on fuzzy logic to export consortia in Iran.

The rest of the study is organized as follows: In section 2, the theoretical foundations and literature review are provided. Section 3 describes the methodology and data analysis techniques. Section 4 presents data analysis and results, and section 5 provides conclusions and recommendations.

2. LITERATURE REVIEW

Researchers have conducted various studies on export consortia over the past years, each of which has made a significant contribution to the development of export consortia literature, developed different concepts and used specific methodologies. The summary of past domestic and foreign studies is given below.

According to investigation presented by Mousavi Neqabi and Anoushe (23) on South Pars Phase 11 agreement was concluded with a consortium of France's Total, China's CNPC, and Iran's Petropars. The first part of the contract includes the construction of two production platforms and two pipelines, and the second part includes the construction of pressure-boosting platforms. According to the reviews, this is a service and buy-back agreement. In this type of agreement, the motivation of investors is increased and the interests of both parties are aligned as a result of making changes compared to conventional buy-back agreements.

Also Mousavi Neqabi and Anoushe (24) showed that the development of SMEs is one of the key requirements of balanced regional development, considering their role in job creation and fair distribution of wealth. Cluster development is one of the strategies used in regional economic development programs of many countries for the development of SMEs. Although SMEs have many advantages over large enterprises, there are limitations on the development of SMEs in the areas of finance, marketing, production, R & D, etc., due to limited resources.

Yan et al. (25) found SMEs make an important contribution to economic-social development through job creation, the use of people's small capital in productive work, fair distribution of wealth, balanced development of regions, exploitation of regional advantages, etc. However, SMEs face financial, marketing, knowledge, information, and human resource limitations due to their small size. Policymakers have put various strategies on their agenda, such as supporting financing, developing domestic and export markets, promoting technology, empowering human resources,

and networking for the development of SMEs according to their limitations. In addition, Yan et al. (25) investigated on the strategies of entering foreign markets, foreign investment performance, and the effect of international trade and product compatibility on these factors were investigated in pharmaceutical companies affiliated to the syndicate using the principles of marketing management and international trade during six-months from March 2017 to September 2018. According to the results of the descriptive statistics of the variables, the strategies of entering foreign markets have the highest average, product compatibility has the smallest average and range of changes, and foreign investment performance has the lowest standard deviation, indicating the unanimity of opinion among the respondents. The results also indicated that there is a significant positive relationship between the strategies of entering foreign markets and foreign investment performance, between the strategies of entering foreign markets and international trade, and between the strategies of entering foreign markets and product compatibility. It was also found that international trade plays a mediating role in the relationship between the strategies of entering foreign markets and foreign investment performance.

Mousavi Niarki et al. (26), conducted a study on identification and prioritization reflecting on export of products of knowledge-based companies. The data needed to answer the questions were collected using questionnaires with open questions that were given to experts, namely 5 university professors and 5 marketing managers of knowledge-based companies located in Tehran Science and Technology Park. The experts were interviewed to identify the factors affecting the commercialization of products. In this way, 17 indicators in 4 sub-indicators were identified. Finally, 5 sub-indicators were removed from the main sub-indicators due to their lack of importance, and 12 final indicators remained. All the data were analyzed using the ANP method. According to the results, the rate of job creation by technology in the case of commercialization and mass production with a weight of 0.99, the presence of detailed regulations, instructions, and rules with a weight of 0.97, and the technical complexities of technology with a weight of 0.96 had the highest weights among the sub-indicators and were ranked first to third. The other weights obtained received other ranks. Ahmadi et al. (27) developed a comprehensive, quantitative hybrid design research method for knowledge-based companies.

Du et al. (28) summarized the main problems and obstacles in the protection of wildlife resources and their use in China. Based on Analytical Hierarchy Process (AHP), the main technological factors affecting on conservation and use of wildlife resources in China were identified. Finally, the direction of future wildlife conservation research development based on critical factors is discussed. It can provide guidance for the

development of wildlife resource conservation and utilization for a sustainable ecosystem in China.

Nozari et al. (29) argued by identifying and prioritizing these factors plays an important role in establishing a balance between the domestic economy and the global economy and determining the position of the food industry in the volume of trade and export products of the country. To this end, researcher-made questionnaires including 4 main measures and 15 main indicators were designed and distributed among 31 food exporting companies in Alborz Province. The validity of the questionnaires was confirmed through interviews with experts, and their reliability was confirmed using Cronbach's alpha. The weights of the measures were then determined using the AHP method, and the best indicators were prioritized to determine the factors determining export performance. The results suggested that the objective features of the company had the most weight and that the export commitment had the least weight among the measures. Besides, the first to third priorities respectively belonged to "export drivers", "direct export channel", and "duration of export experience".

Moosavi et al. (30), analyzed supply chain disruptions during the Coronavirus era and presented management strategies in order to create a stable and resilient supply chain.

Gillespie & Riddle (31) conducted a study on export promotion organization emergence and development. In most of the studies, the export promotion organization's performance is evaluated by evaluating the profits of the companies, awareness, understanding, and use of the organization's services. A small number of studies describe how the export promotion organization makes decisions about providing services. This study was conducted to provide a better understanding of how and why to determine export promotion organizations and provide and modify proposals for their services. It first reviewed the literature on the export promotion organization and suggested that both macro and micro approaches derived from the literature can be adapted to more effectively explore the effect of export promotion organization emergence and changes in its services.

Antoldi et al. (32) analyzed the performance of export consortia as cooperation, facilitating the achievement of innovation, and the export performance of Brazilian members through research consortia with different companies and economic sectors. According to the results of the survey analysis using descriptive statistics and Pearson's correlation, the enterprises sought to comply with international technological standards.

Bekerman et al. (33) suggested that the internationalization of SMEs is now a major challenge for the development of Argentina's economy due to the high concentration of Argentina's exports in the hands of some large companies. In this study, the experience of export consortia in Argentina was examined as a tool that

can play an essential role in the process of internationalization of SMEs.

Forte & Oliveira (4) argued that exporting is an essential strategy for the growth and survival of enterprises, especially SMEs. However, SMEs generally cannot overcome internal and external export barriers, and a consortium can help them to internationalize. Accordingly, this study was conducted mainly to identify the main effects of a consortium on the member enterprises as well as the gap in the literature. So, it reviewed the available empirical studies, which are mainly focused on case studies of export consortia. Export consortia can be effective in different areas of enterprises such as finance, market, and credit and help them overcome some export obstacles. Identifying the weaknesses of the literature suggests that future studies should focus on empirical studies with larger samples and consider other possible factors affecting exports to conduct a more detailed empirical analysis of the effects of consortia on enterprises' exports.

The reviewed domestic and foreign studies are listed in Table 1 based on their objectives and methodologies. Investigations indicate that the studies have neglected to propose a comprehensive approach that analyzes the state of the export consortium of SMEs and provides an accurate prediction of their future performance. So, the most important innovations and contributions of the study are as follows:

- Analyzing and recognizing the factors affecting the export of SMEs;
- Bringing the study closer to reality using a fuzzy inference engine;
- Developing an SD model to check and predict the model's future performance for making decisions about the export of SMEs.

3. METHODOLOGY

The methodology is referred to as a set of activities performed to determine where, how, and with what tools data is collected and analyzed to obtain the necessary results. This is a basic and applied-developmental study based on the objectives. Basic research is a theoretical one that is conducted solely to develop knowledge without a specific applied objective. Basic research is conducted for one of the objectives of science, which is a kind of science for science. This kind of research attracts a lot of attention because they pave the way for other studies (34). Applied research is used to meet human needs and improve and optimize tools, objects, and patterns in the development of welfare and comfort and the improvement of human living standards by using the cognitive background and information provided through basic research (34). Developmental studies are conducted to develop a more comprehensive indicator of the results of studies and expand their scope. Thus, developmental studies are those that are carried out as a continuation of previous studies to investigate additional dimensions and issues. These studies have a mixed approach. The mixed method uses a combination of quantitative and qualitative methods simultaneously. As a combination of quantitative and qualitative methods, mixed methods provide an opportunity for researchers to bring together the methodologies, designs, models, and methods used in a single study (34).

This is a basic and applied-developmental study based on objectives or results. It is also a descriptive exploratory study in terms of method and a survey one in terms of the data collection method. The data is collected and analyzed using a mixed (qualitative-quantitative)

TABLE 1. Literature review

Study type	Author	Year	Objective	Methodology	Other factors
Domestic	Ortega	(16)	Examining technical, economic, and legal dimensions of the agreement	Two-part analysis	-
	Mousavi Neghabi & Anousheh	(23)	Examining the role of the cluster in the development of sustainability of small enterprises	Cluster analysis	Sustainability
	Mousavi Neghabi	(24)	Examining solutions for sustainable development of small enterprises	Networking	Sustainability
	Yan et al.	(25)	Examining the effect of international trade on entering foreign markets	Statistical analysis	-
	Mousavi Niarki et al.	(26)	Prioritizing factors affecting the export of knowledge-based companies	ANP	-
	Ahmadi	(27)	Identifying and prioritizing factors affecting food exports	AHP	-
Foreign	Antoldi et al.	(32)	Examining export performance to obtain innovation	Statistical analysis	-
	Bekerman et al.	(33)	Examining the export productivity of small industries	Statistical analysis	-
	Forte & Oliveira	(4)	Reviewing small business exports	Statistical analysis	-

method. Moreover, the study is part of the critical paradigm. The statistical population is selected because the Iran Trade Promotion Organization is responsible for strengthening and developing export capacities at the country level, including export consortia. The sample consisting of 11 experts and consultants of export consortia in the Iran Trade Promotion Organization willing to cooperate in the study is selected by purposive expert sampling. The experts have at least 10 years of experience and study about export and export consortia. The demographic features of the population are given in Table 2.

In this study, the data are collected using library research and field methods. The data on the subject description and literature review are collected using the library research method and referring to domestic and foreign books, papers, and theses (via the Internet). The data required by the field section are collected in qualitative and quantitative phases.

In the qualitative phase, in-depth, exploratory, and collaborative interviews began by asking the following questions: "What are the main success factors of private sector export consortiums in Iranian industries?" and "What steps should be taken to establish private sector export consortia in Iranian industries?". Eleven focus group meetings are then organized with the experts. In each session, an expert is selected as a facilitator to explain the main success factors of export consortia and the steps to establish an export consortium based on his/her knowledge and experience. In the quantitative phase, FCM technique questionnaires are designed according to the main factors identified in the previous phase and are distributed among the experts. The experts' opinions concerning the questionnaires are then obtained through frequent contact with them. A brainstorming session is held with the experts to determine if-then rules for the FIS.

TABLE 2. Demographic features of the population

Expert	Gender	Age (year)	Education level	Work experience (year)
1	Male	50	Master's degree	20
2	Male	52	PhD.	26
3	Male	44	PhD.	11
4	Male	48	Master's degree	19
5	Male	45	Master's degree	18
6	Male	43	Master's degree	14
7	Male	49	PhD.	19
8	Female	40	Master's degree	16
9	Male	56	PhD.	28
10	Female	45	PhD.	18
11	Male	43	Master's degree	15

The questionnaires concern the FCM technique. They are the matrixes of the power of communication between the main and secondary factors, where the experts express their opinions about the relationship and the degree of effects between the two factors.

The reliability of the measurement tool should be ensured before performing any data analysis and statistical inference (28). Reliability indicates whether the same results will be obtained if the study is repeated with the same test. In this study, different data collection tools are used because it consists of qualitative and quantitative phases.

The FCM questionnaires are used in the quantitative phase. Content validity is evaluated to ensure the validity of the questionnaires. In the FCM technique, the matrix for determining relationships and the degree of effects of the factors are the same questionnaires whose validity is confirmed by the experts. The techniques used to analyze the data and the reasons for their use can be seen in Table 3.

Various problem-solving techniques have been proposed, each of which has specific features and conditions of application. In this study, decisions are made using FCM, SD, and FIS, which are briefly described below.

TABLE 3. The techniques used to analyze the data and the reasons for their use

Objectives	Techniques	Reasons
The first objective: identifying the main success factors of export consortia in Iranian industries	Grounded theory based on qualitative coding	The qualitative coding method is used to analyze the qualitative data in the grounded theory approach (35)
The second objective: determining the steps to establish export consortia in Iranian industries		
The third objective: designing a fuzzy roadmap of the main success factors of export consortia in Iranian industries	FCM	The FCM technique is used to analyze causal maps and improve the ability of decision-makers to understand the dynamic behavior of causal cognitive maps. The technique represents the causal relationship between concepts and analyzes inference patterns.
The fourth objective: Fuzzy dynamic modeling for private sector export consortia in Iranian industries	Fuzzy logic-based SDM	SDM does not exclusively deal with future quantitative prediction but seeks to gain extensive knowledge about the mutual dynamic relationship between the system components [39]

3. 1. Fuzzy Cognitive Mapping (FCM) Technique

Kosko (36) defines an FCM as a directed graph to show the causal relationships between factors, which is specified by a number in the range [-1,1]. In this model, the SD is shown by simulating the interactions between the concepts and factors of the system. The FCM technique is used to show both quantitative and qualitative data. The inputs obtained from the experience and knowledge of experts in the subject matter are required for the development of an FCM. So, in this technique, the accumulated experiences of people are integrated with the existing knowledge in the field for which the model is drawn, and the causal relationships between the factors constituting the system are formed accordingly (37). An FCM model is made up of a set of nodes or concepts represented with abbreviations in Equation 1,

$$C_i, \quad i = 1, 2, \dots, n \tag{1}$$

In this model, each node represents a key factor in the modeled system and is valued by Equation 2.

$$i = 1, 2, \dots, n, \quad A_i \in [0,1] \tag{2}$$

The model nodes are internally connected by weighted arcs. If a fuzzy cognitive map with n nodes C_j is given, the value of each node in each iteration can be calculated as Equation 3.

$$A_i^{t+1} = f(A_i^t + \sum_{j=1}^n A_j^t W_{ij}) \tag{3}$$

where A_i^{t+1} is the quantity of concept C_j at the time of $t + 1$, and A_j^t is the quantity of concept C_j at the time t . In addition, W_{ij} corresponds to the fuzzy weight between two groups, and f is a threshold function that converts the result of the coefficient into a number in the interval [0,1]. The logistic function, which is given in Equation 3, is the most prevalent kind of function f .

$$f(x) = \frac{1}{1+e^{-\lambda x}} \tag{4}$$

where $\lambda > 0$ determines the slope of the continuous function f .

$W_{ij} > 0$: indicates a positive cause and effect relationship

$W_{ij} < 0$: indicates a negative cause and effect relationship

$W_{ij} = 0$: no relationship

The methodology used in this research contains 6 phases as follows (38, 39,37, 40):

Step 1: Forming the relationship matrix or determining the relationships (effectiveness and impressionability) between the factors: Research professionals identify the relationships between the required parameters in this stage. A factor's relationships with its linked sub-factors are also established. Based on professional consensus, the determined relationships have been established.

Step 2: Determining the intensity of relationships based on linguistic variables: The linguistic variables are

initially defined in this stage. Then, depending on linguistic factors, each research specialist evaluates the strength of the associations under consideration (very little, little, medium, much, very much).

The number of linguistic variables multiplied by the relevant fuzzy number yields a result that represents the intensity of relationships as a fuzzy number. At this point, each relationship's fuzzy number has to be determined using the following formula. We therefore have:

J : set of linguistic variables ($j \in J$)

j : Linguistic variables ($j = VL, L, M, H, VH$)

K : The set of triangular fuzzy number values (upper bound, most probable, lower bound) ($k \in K$)

k : Triangular fuzzy number values (upper bound, most probable, lower bound) ($k = l, m, u$)

x_{jk} : The value of linguistic variable j with triangular fuzzy number bound k

I : The set of intensity of the factors' effectiveness on each other($i \in I$)

i : The intensity of the factors' effectiveness on each other($I=VL,L,M,H,VH$)

$f_i^{(A \rightarrow B)}$: The frequency of experts' opinions regarding the effectiveness of factor A on factor B with the effectiveness intensity i

$\alpha_k^{(A \rightarrow B)}$: The value of the triangular fuzzy number (upper limit, most probable, lower limit): k regarding the effectiveness of factor A on factor B . It is shown in the equation below.

$$\alpha_k^{(A \rightarrow B)} = \sum_{i=VL}^I \sum_{j=VL}^J f_i^{(A \rightarrow B)} x_{jk} \quad \forall k \in K \tag{5}$$

Step 3: De-fuzzification: The fuzzy mean method in Equations 3-6 were used for de-fuzzification.

$$Score_{(Crisp)}^{(A \rightarrow B)} = \frac{\alpha_l^{(A \rightarrow B)} + 4\alpha_m^{(A \rightarrow B)} + \alpha_u^{(A \rightarrow B)}}{6} \tag{6}$$

Step 4: effectiveness power and impressionability capacity: In this stage, we try to figure out how much effectiveness each component has and how much impressionability it can have. In this sense, each factor's effectiveness and impressionability are combined concerning other factors. That is, the total effectiveness power and the total impressionability capacity of each factor are obtained separately.

Step 5: Determining the axial index: The total of each factor's effectiveness and impressionability is added together to determine the axial index in this stage. The axial index demonstrates the significance of the variables. Indeed, a factor is referred to the superior factor or axial the more entire effectiveness power and impressionability ability it possesses.

Step 6: Designing fuzzy cognitive map: The identified relationships, effectiveness power, impressionability capacity, and axial index of each element are used to create the fuzzy cognitive map in this stage.

3. 2. System Dynamics The model given in this research continues its path based on the following steps, which are five in the system dynamics method (38).

Step 1: problem articulation: Modelers should clearly define their modeling objectives for themselves and completely comprehend the true problem, not just its side effects. A model, then, is a condensed portrayal of the real world.

Step 2: Formulating dynamic hypotheses: The boundary of the model is established at this point by identifying the major variables influencing the problem under investigation. Using the information already known about the problem, causal circles are then formed and gradually filled in to produce a final simplified representation of the problem's actual occurrence.

Step 3: Formulating a simulation model: The model is put into action when dynamic hypotheses and system boundaries are generated. The dynamic interactions between the elements in this mental model are frequently so complex that they are difficult to comprehend. This necessitates simulating and applying the model in a virtual environment. There are other programs available for this purpose, however, Vensim software is employed in this study.

Step 4: Model testing and its validation: Comparison of the model's simulated behavior with real-world behavior is essential. This comparison demonstrates that the model is ready to be utilized as a foundation for policy.

Step 5: Policy-making: It entails resolving tactics, frameworks, and new decision-making policies to enhance the system. To attain a more successful outcome in this direction, many integrated policies and scenarios are typically employed.

3. 3. Fuzzy Interference System There are two significant types of fuzzy inference system: Mamdani and Sugeno. The most popular inference system in

literature, Mamdani's fuzzy inference system, was one of the first fuzzy control systems. Fuzzy sets must be used as both input and output for Mamdani. After the aggregation operation, the output becomes defuzzified. In a Mamdani fuzzy inference system, the input variables are combined in such a way that if x_1, x_2 and x_n are equal to $A_1, A_2,$ and A_n , then y is equal to B , where x_i ($i = 1, 2, 3, \dots, m$) are input variables and y is an output variable. A_1, A_2, \dots, A_n and B represent the linguistic terms. The inputs in Mamdani fuzzy inference system may be clear or unclear (39).

4. RESULTS ANALYSIS

The grounded theory technique was used in this study to identify the key success criteria of private-sector export consortia in the Iranian industry. Following the interviews, the information was categorized using three steps of qualitative coding (open, axial and selective) (40).

"Open coding" is the initial stage of data analysis. In the current study, the interviews were initially open-coded into ideas pertinent to the research issue. Axial coding is connected to the second phase. Open codes are now grouped into many categories (subcategories) according to their shared content. In other words, depending on shared axes, the concepts were compared to one another and classified into subclasses. "Selective coding" is the name of the third level. Generally, 26 axial codes, 7 selective codes, and 142 open codes were found. The results of qualitative coding using the grounded theory approach are displayed in Table 4 (41).

The fuzzy cognitive map approach (FCM) was employed to create a fuzzy cognitive strategic map for the primary success determinants of private sector export consortia in Iranian industries. Six phases were used in the fuzzy cognitive mapping approach. Accordingly, the matrix of the strength of communication and the power

TABLE 4. Qualitative coding to identify the main success factors of private sector export consortia in Iranian industries

Main categories code	Main categories (selective codes)	Sub-categories code	Sub-categories (axial codes)
FCMs	Features of consortium members	FCMs1	Consortium members' experiences
		FCMs2	The export share of consortium members
		FCMs3	Power of production/supply of consortium members
EOP	Export assistance programs	EOP1	Identifying potential export markets and creating a database related to their features
		EOP2	Export consulting inside and outside the country
		EOP3	Participating in foreign international exhibitions
		EOP4	Establishing branches in target markets
		EOP5	Online advertising of export goods (online exports)
		EOP6	Determining the export strategy (direct, indirect and cooperative)

CB	Consortium strengthening factor	CB1	Establishing a teamwork culture instead of a solitary entrepreneurial spirit
		CB2	Co-branding and its strengthening
		CB3	Quality assimilation and its improvement
		CB4	Value-creation through after-sale services
		CB5	Competitive pricing
ES	Recognizing export support	ES1	Familiarity and using the support of government organizations (such as receiving subsidies, services provided by the trade development organization, facilitating export procedures, etc.)
		ES2	Awareness and use of support by incubation centers and export accelerators
		ES3	Knowledge and use of private and foreign government networks
TFs	Transnational factors	TFs1	Using foreign investments
		TFs2	Certificate of international standards
		TFs3	Forming the global trade promotion team
		TFs4	Employing foreign expert human resources
GFs	Governmental factors	GFs1	Efforts to establish cooperation between business institutions of trading countries
		GFs2	Financing through export-oriented securities
PFs	Product features	PFs1	Improving the quality of existing products
		PFs2	Developing new products
		PFs3	Attractive packaging

of effectiveness, impressionability and axial index about the primary success factors and associated sub-factors was obtained. In this regard, expert opinions were gathered to determine the matrix of communication between the factors and the strength of the relationship between them. The visual representation of the fuzzy

cognitive map is created following Figure 1 based on the data acquired in the earlier phases, the creation of the relationship matrix between the secondary variables, and the relationship matrix of the final relationship between the key elements.

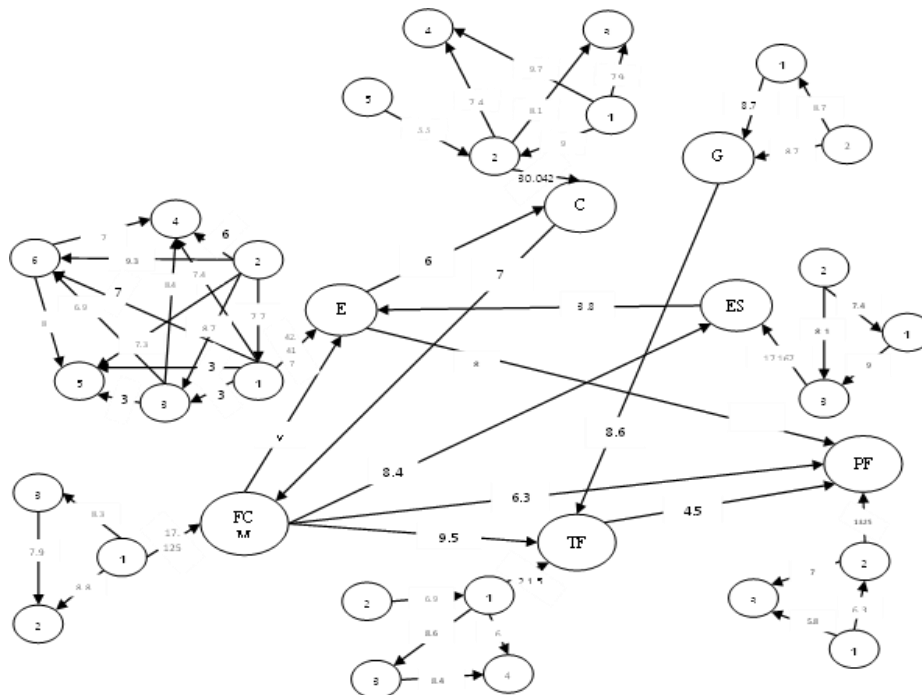


Figure 1. Fuzzy cognitive map for the main success factors of private sector export consortia in industries

As shown in Figure 1, various factors impact each other with different coefficients due to the relationships between the found seven major components. Additionally, each primary factor's related secondary factors each have a separate coefficient of interaction. The most significant sub-factor, which is regarded as the interface of those sub-factors with the fuzzy cognitive map, is that associated with each main factor that has the maximum axial index. Some highest axial indices among the related factors that should be emphasized are sub-factors of "consortium members' experiences" with an axial index of 125/17 (related to the features of the consortium members), "familiarity with potential export markets and creating a database related to their features" with an axial index of 42/417 (related to the expert operational plan), "co-branding and its strengthening" with an axial index of 30.042 (related to the strengthening factor of the consortium), "awareness and use of foreign private and government networks " with an axial index of 17.167 (related to recognition of support exports), "using foreign investments" with an axial index of 21/5 (related to transnational factors), "efforts to establish cooperation

between the business institutions of the trading countries" and "financing through export-oriented securities" both with an axial index of 8.667 (related to government factors), and "development of new products" with an axial index of 13.25 (related to product features) (42).

The following uses a mix of system dynamic modeling techniques (in Vensim software) and fuzzy inference system (in MATLAB software) to construct the fuzzy dynamic model of private sector export consortia in Iranian industries. The stock and flow chart are produced following Figure 2 based on the key factors discovered, the relationships between the main factors, and the relationships between the sub-factors related to each main factor.

4. 1. Stock Variable (State Variable)

The "performance of export consortia" is taken into account as a stock variable in the system dynamics model because flow variables (rates), which are the primary success factors of private sector export consortia in Iran's industries, depict the accumulation of activities of export

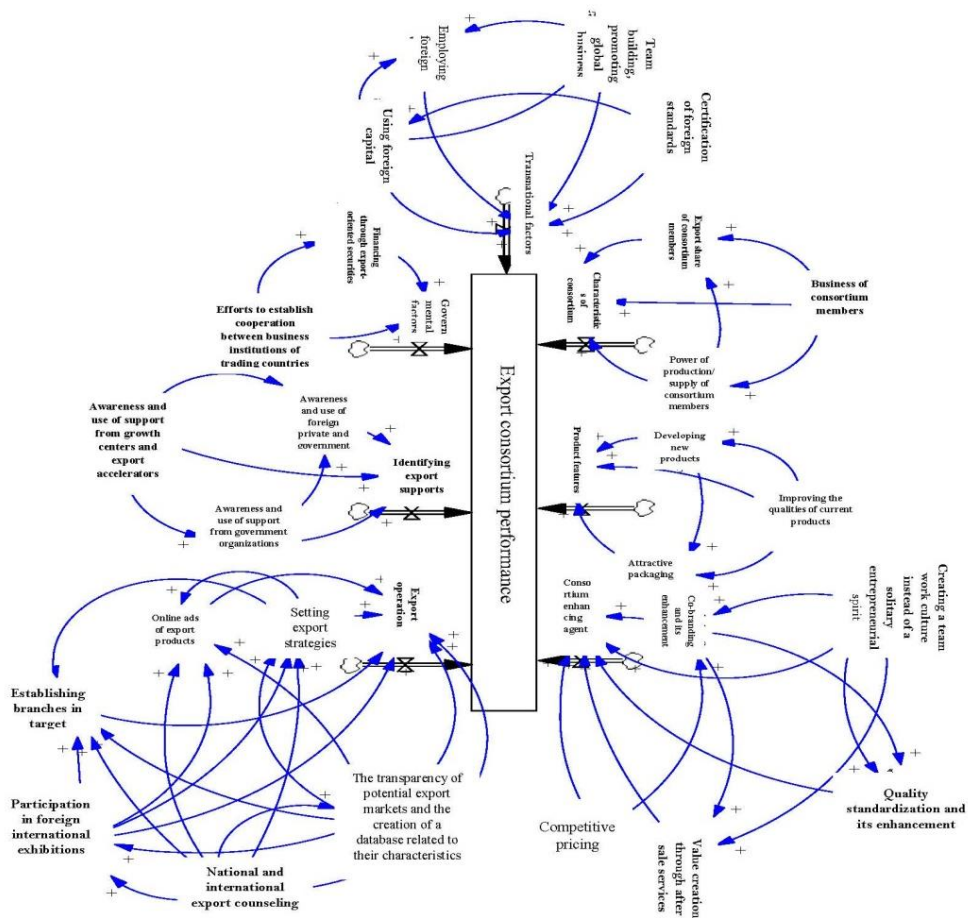


Figure 2. The stock and flow diagram of the presented model

consortia. The initial value of "performance of export consortia" is taken in this study to be 0.2. The integral of the sum of the flow or rate variables, which are the primary success determinants for export consortia from 2011 to 2031, is used to determine the performance of export consortia (stock variable), which has been shown in Equations 7 and 8.

$$\int (\text{consortium member features} + \text{operational program exports} + \text{consortium strengthening agent} + \text{export recognition support} + \text{transnational agents} + \text{governmental agents} + \text{product features}) \quad (7)$$

$$\int (\text{FCM} + \text{EOP} + \text{CB} + \text{ES} + \text{TF} + \text{GF} + \text{PF}) \quad (8)$$

4. 2. Flow Variables (Rate Variable) The primary export consortium success factors in this study's flow variables are listed below. Table 5 generally provides instructions on how to determine the variables of the study model.

Features of consortium members: The features of consortium members are determined by a variety of factors, including "consortium members' experiences," "consortium members' export share," and "consortium members' production/supply power". When analyzing the connections between these variables, DELAY1I and RAMP functions were utilized to take into account their significance and effectiveness.

Export assistance program: This variable includes a series of different activities such as "familiarity with potential export markets and creating a database related to their features", "national and international export consultation", "participation in international exhibitions abroad", "creating branches in the target markets", "online advertising of export goods" and "determining the export strategy", all of which and the relationships between them constitute the export assistance program. The SMOOTH, STEP, DELAY1I, and RAMP functions have been employed in the interaction between these elements following their meaning and effectiveness on one another. The variables "features of consortium members" and "recognition of export support" is also incorporated in the export assistance program based on the cause and effect relationships of the key success criteria.

Consortium strengthening factor: This variable consists of a series of different activities such as "creating a teamwork culture instead of the individual spirit of entrepreneurship", "co-branding and its strengthening", "standardization of quality and its improvement", "value creation through after-sales services" and "competitive pricing" which together with the relationships between them constitute the strengthening factor of the

consortium. In the relationships between these components, under their significance and mutual effect, DELAY1I and RAMP functions have been applied. Additionally, the variable "export assistance program" is added to the consortium strengthening factor based on the cause-and-effect correlations of the primary success variables.

Identifying export supports: This variable includes a variety of activities, including "awareness and use of support from government organizations," "knowledge and understanding and use of support from incubation centers and export accelerators," and "recognition and use of private and government networks abroad." These activities individually and in combination together make up the recognition of export support. The RAMP function has been applied to the relationship between these variables while taking into account their significance and effectiveness. Additionally, the variable "features of the consortium members" is included in the recognition of export support based on the causal links of the key success criteria.

Transnational factors: The activities included in this variable, along with their relationships, constitute transnational factors. These activities include "Using Foreign Investments," "Certificate of International Standards," "Establishing a Global Trade Promotion Team," and "Employing Foreign Expert Human Resources." The SMOOTH, DELAY1I, STEP, and RAMP functions have been employed in the relationships between these components based on their concepts and effectiveness on one another. Furthermore, the variables "features of consortium members" and "government factors" are added to the transnational factors based on the cause-and-effect correlations of the primary success factors.

Governmental factors: A variety of activities, including "efforts to establish cooperation between commercial entities of trading countries" and "financing through export-oriented securities," are included in this variable. These activities, along with the interconnection between them, are what are known as government agents. STEP and RAMP functions have been employed in the interaction between these components based on their concept and effectiveness.

Product features: The actions included in this variable, which together with their relationships create the qualities of the product, are "increasing the quality of existing products," "creating new products," and "attractive packaging." The relationship between these parameters has been examined using the DELAY1I and RAMP functions, taking into account their significance and effectiveness. Additionally, the variable "features of the consortium members" is added to the product features based on the causal relationships between the primary success drivers.

TABLE 5. Method of calculating (formula) variables of the research model

Research model variables	Variables' code	Calculation method (formula)
export consortia performance	ECP	$0.2 + \int_{1390}^{1410} (FCMs + EOP + CB + ES + TFs + GFs + PFs)$
Features of consortia members	FCMs	FIS * DELAY1 ((RAMP (((FCMs1 + FCMs2 + FCMs3)/3) + (ECP)/2), 1395, 1405)), 1395)
The export share of consortium members	FCMs2	DELAY1I (((FCMs1 + FCMs3)/2), 1395, 0)
Power of production/supply of consortium members	FCMs3	RAMP (((FCMs1 + FCMs2)/2), 1395, 1405)
Export assistance programs	EOP	FIS * ((RAMP (((EOP1 + EOP2 + EOP3 + EOP4 + EOP5 + EOP6)/6), 1395, 1405) + ((ECP + ES + FCMs)/3)/2)
Identifying potential export markets and creating a database related to their features	EOP1	SMOOTH (((EOP2 + EOP3 + EOP6)/3), 1395)
Participation in international exhibitions	EOP3	DELAY1I (((EOP2 + EOP4 + EOP5)/3), 1395, 0)
Establishing branches in target markets	EOP4	STEP (((EOP1 + EOP2 + EOP6)/3), 1395)
Online advertising of export goods (online exports)	EOP5	RAMP (((EOP1 + EOP2 + EOP3 + EOP6)/4), 1395, 1405)
Determining the export strategy (direct, indirect and cooperative)	EOP6	STEP (((EOP2 + EOP3)/2), 1395)
Consortium strengthening factor	CB	FIS * ((RAMP (((CB1 + CB2 + CB3 + CB4 + CB5)/5), 1395, 1405) + ((EOP + FCMs)/2)/2)
Co-branding and its strengthening	CB2	DELAY1I ((RAMP (((CB1 + CB5)/2), 1395, 1405)), 1395, 0)
Quality standardization and its enhancement	CB3	RAMP (((CB1 + CB2)/2), 1395, 1405)
Value creation through after-sales service	CB4	RAMP (((CB1 + CB2)/2), 1395, 1405)
Identifying export support	ES	FIS * ((RAMP (((ES1 + ES2 + ES3)/3), 1395, 1405) + (FCMs)/2)
Familiarity with and using the support of government organizations (such as receiving subsidies, services supplied by the trade development organization, facilitating export procedures, etc.)	ES1	RAMP (ES2, 1395, 1405)
Identifying and utilizing private and international government networks	ES3	RAMP (((ES1 + ES2)/2), 1395, 1405)
Transnational factors	TFs	FIS * (SMOOTH (((TFs1 + TFs2 + TFs3 + TFs4)/4), 1395) + ((FCMs + GFs)/2))
Using foreign investments	TFs1	DELAY1I (((TFs2 + TFs2)/2), 1395, 0)
Forming the global trade promotion team	TFs3	RAMP (TFs4, 1395, 1405)
Employing international expert human resources	TFs4	DELAY1I (STEP ((TFs1 ,1397)), 1395, 0)
Governmental agents	GFs	FIS * ((RAMP (((GFs1 + GFs2)/2), 1395, 1405) + (ECP)/2)
Financing through export-oriented securities	GFs2	DELAY1I (GFs1, 1395, 1405)), 1395, 0)
Product features	PFs	FIS * ((RAMP (((PFs1 + PFs2 + PFs3)/3), 1395, 1405) + ((ECP + FCMs)/2)/2)
Developing new products	PFs2	DELAY1I (PFs1, 1395, 1405)), 1395, 0)
Attractive packaging	PFs3	RAMP (((PFs1 + PFs2)/2), 1395, 1405)

4. 3. Simulation and Strategy Selection After the model and formulation were developed, a simulation was carried out with Vensim software. In this part, several policy and performance scenarios for export consortiums are explored utilizing the feedback mechanisms developed for the model. After the model and formulation were developed, a simulation was carried out with Vensim software. In this part, several

policy and performance scenarios for export consortiums are explored utilizing the feedback mechanisms developed for the model. The simulation time unit "year" has been chosen, and the simulation's duration is 21 years, taking into account that reports are prepared and results are reviewed yearly. The findings indicate that the performance of the export consortium has improved over time as a consequence of improvements made to the key

success determinants that have been identified. Finally, ideas were put out and several scenarios were examined based on the key success elements that had been found.

The model's implementation findings demonstrate that export consortiums may provide outstanding outcomes in the upcoming years if they appropriately apply the key success elements that have been discovered. Overall, the findings show that the successful execution of the export consortium's key success determinants raises the performance level of export consortia (Table 6).

Hypothesis/Scenario 1: Considering the consortium members' features improves the performance of export consortiums.

The number of the consortium members' features is effectively determined in this part by two separate currents, which are as follows:

1. Current one: To generate the minimal level of performance that is acceptable for the features of the consortium members, the consortium attempts to modify all the sub-factors that are connected to those qualities (Figure 3). Using a fuzzy inference system that establishes the weight of the variables in the relationships of the system dynamics approach, the choice of a combination of these sub-factors has been made. Through if-then rules, this decision support system also serves as an audit for the upper and lower bounds of the attributes of consortium members.
2. Current two: The consortium is attempting to quantify the impact of the key success variables on the features of the consortium members in this current.

According to the findings (Figure 3), the "features of consortium members" factor is influenced by the pertinent sub-factors and "export consortium performance."

TABLE 6. The performance results of consortia during 2011-2031

Year	Export consortia performance	Year	Export consortia performance
2011	0.2	2022	25.2407
2012	0.336312	2023	42.2763
2013	0.512666	2024	68.596
2014	0.740848	2025	108.04
2015	1.03612	2026	165.707
2016	1.41822	2027	248.327
2017	1.91272	2028	355.282
2018	2.86319	2029	493.735
2019	4.74533	2030	672.959
2020	8.30188	2031	904.956
2021	14.6215	---	---

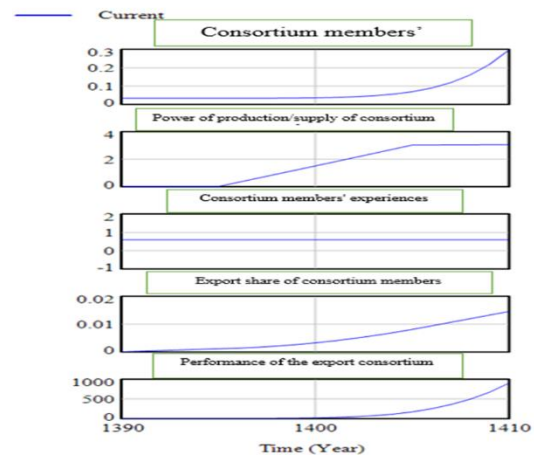


Figure 3. The results of the features of the consortium members and their influencing factors

Hypothesis/Scenario 2: Considering the export operational plan improves the performance of export consortiums.

The quantity of the export operational plan in this section is determined by two separate currents, which are as follows:

1. Current one: The consortium strives to achieve a minimal level of acceptable performance for the export operational plan during this step by adjusting all the connected sub-factors that have an impact on it (Figure 4). Using a fuzzy inference system that establishes the weight of the variables in the relationships of the system dynamics approach, the choice of a combination of these sub-factors has been made. Through if-then logic, this decision support system also serves as an audit for the export operating plan's upper and lower limitations.
2. Current two: The consortium is now attempting to quantify the influence of the key success elements on the export operating plan (Figure 4).

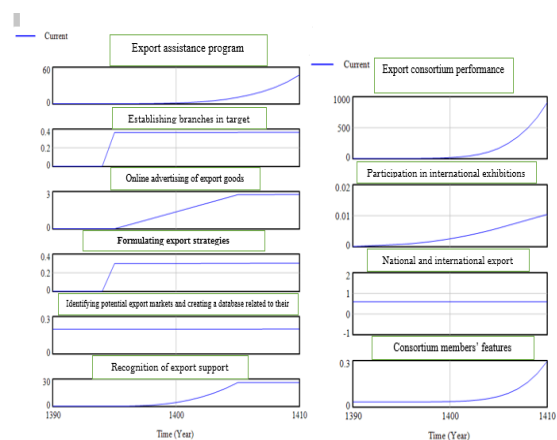


Figure 4. The results of the export assistance program and its affecting factors

According to the findings (Figure 4), the export assistance program is influenced by the pertinent sub-variables as well as the factors "features of consortium members," "awareness of export support," and "performance of export consortia."

Hypothesis/Scenario 3: Considering the consortia strengthening factor improves the performance of export consortia.

The quantity of the consortium strengthening factor in this section may be calculated using two distinct currents, which are as follows:

1. Current one: The consortium works to generate the lowest acceptable performance level for the consortium amplifier throughout this current by adjusting all the sub-factors that are connected to and have an impact on the consortia amplifier (Figure 5).

Using a fuzzy inference system that establishes the weight of the variables in the relationships of the system dynamics approach, the choice of a combination of these sub-factors has been made. Through if-then rules, this decision support system also serves as an audit for the maximum and lower bounds of the consortium enhancing factor.

2. Current two: The consortium attempts to evaluate the impact of the key success elements that are applied to the factor that strengthens the collaboration in this current (Figure 5).

According to the findings (Figure 5), the consortia strengthening factor is influenced by the pertinent sub-factors as well as the factors "features of consortium members" and "export assistance programs."

Hypothesis/Scenario 4: Considering the recognition of export support improves the performance of export consortia.

The amount of recognition of export support is determined in this section by two separate currents, which are as follows:

1. Current one: The consortium attempts to alter each sub-factor involved in the recognition of export support

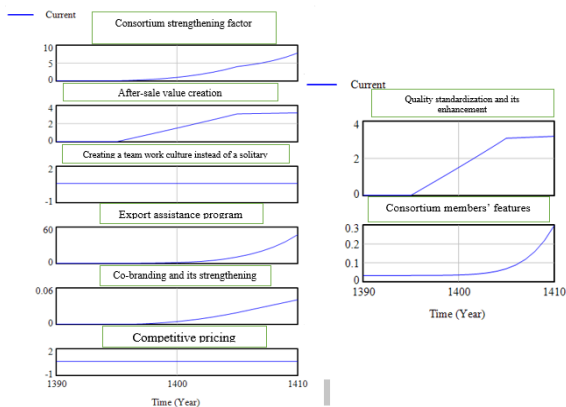


Figure 5. The results of the consortium strengthening factor and its affecting factors

during this process to define the minimum level of acceptable performance for its recognition (Figure 6). Using a fuzzy inference system that establishes the weight of the variables in the relationships of the system dynamics approach, the choice of a combination of these sub-factors has been made. Through if-then rules, this decision support system also serves as an audit for the top and lower limits of the recognition of export assistance.

2. Current two: The collaboration is now attempting to quantify the impact of the key success features on the acceptance of export assistance (Figure 6).

According to the findings (Figure 6), the factor "features of consortium members" and its related sub-factors have an impact on identifying export support.

Hypothesis/Scenario 5: Considering the transnational factors improves the performance of export consortia.

The level of focus on transnational elements in this part is effectively influenced by two separate currents, which are as follows:

1. Current one: The consortium attempts to modify each sub-factor connected to the transnational factors in this current such that the transnational factors perform at a minimal level that is deemed acceptable (Figure 7).

Using a fuzzy inference system that establishes the weight of the variables in the relationships of the system dynamics approach, the choice of a combination of these sub-factors has been made. Through if-then rules, this decision support system also serves as an audit for the top and lower bounds of multinational factors.

2. Current two: The collaboration is attempting to quantify the influence of the key success variables imposed on international elements in this current (Figure 7).

According to the findings (Figure 7), the transnational variables are influenced by the pertinent sub-factors as well as the "features of consortium members" and "government factors."

Hypothesis/Scenario 6: considering governmental factors improves the performance of export consortia.

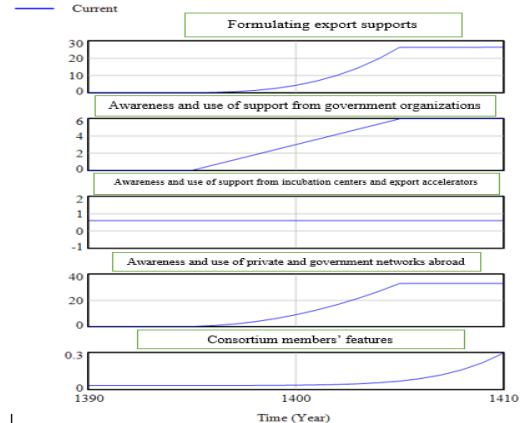


Figure 6. The results of identifying export support and its affecting factors

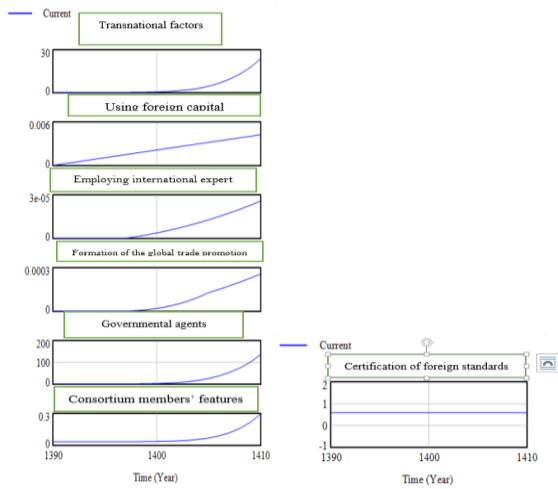


Figure 7. The results of transnational factors and their affecting factors

The degree of consideration given to governmental factors in this part may be effectively determined by two separate currents, which are as follows:

1. Current one: The consortium works to develop the minimal level of acceptable performance for the governmental factors by adjusting all the sub-factors that are relevant to them during this current (Figure 8).

Using a fuzzy inference system that establishes the weight of the variables in the relationships of the system dynamics approach, the choice of a combination of these sub-factors has been made. Through if-then rules, this decision support system also serves as an audit for the upper and lower bounds of government agents.

2. Current two: The consortium attempts to gauge how the key success variables affect government employees during this current (Figure 8).

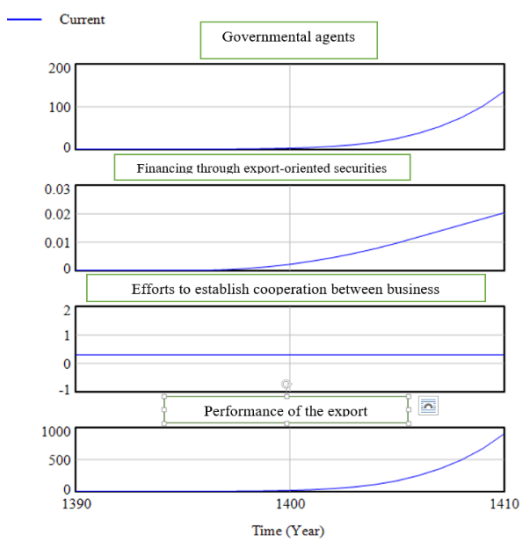


Figure 8. The results of governmental agents and their affecting factors

The findings are depicted in Figure 8, which demonstrates how the relevant sub-factors and "export consortium performance" affect the governmental agents.

Hypothesis/Scenario 7: Considering product features improves the performance of export consortiums.

The following two currents are useful in determining how much attention is paid to product features in this section:

1. Current one: To determine the minimum acceptable performance level for the product features, the consortium adjusts all the associated sub-factors to the product features during this procedure (Figure 9).

Using a fuzzy inference system that establishes the weight of the variables in the relationships of the system dynamics approach, the choice of a combination of these sub-factors has been made. Through if-then rules, this decision support system also serves as an audit for the top and lower bounds of product features.

2. Current two: The consortium is now attempting to quantify the impact of the key success factors on the product features (Figure 9).

4. 4. Model Validation

A developed model must be valid to the individuals engaged in the pertinent events for it to be effective in policy analysis. After passing the validity tests, a model may be used for this purpose to examine how various policies affect the system. Various tests have been applied in this study to determine the model's validity as follows:

Boundary Adequacy test: This test is carried out to see if the model's structure is appropriate for its intended use. In other terms, the following two issues are brought up: 1. Are the primary influencing factors visible in the model as endogenous variables?

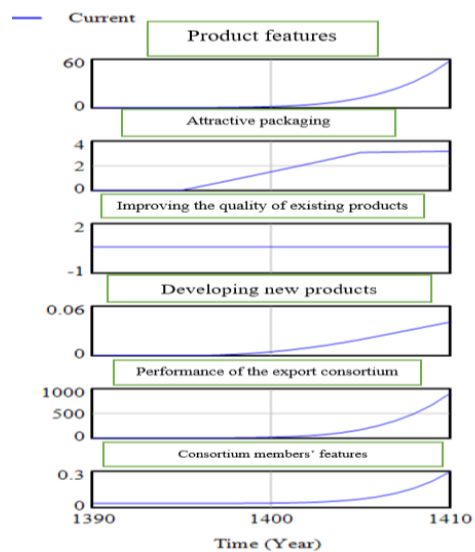


Figure 9. The results of the product features and its affecting factors

2. Is the period taken into proper consideration? All of the factors that affected the export consortium's performance in this study were regarded as endogenous factors. All of the variables included in the suggested model were, in other words, created as endogenous factors. It is important to note that research professionals confirmed the desired variables in the suggested model. It is required to run the model in short- and medium-term periods and check the outcome by expert review or comparison with historical data in the original model to confirm the proper time frame. This led to the implementation of the study model in two short-term (two years from the beginning of 2011 to the beginning of 2013) and medium-term (five years from the beginning of 2011 to the beginning of 2016) seasonal time frames with a time step of 0.25, the results of which are given in Table 7. As shown, it can be concluded that the suggested model may provide a decent approximation of the real behavior in light of the lack of change in the performance of export consortia throughout the short- and medium-term time frames compared to the considered time frame, as well as the validation by the experts.

Structure Assessment: The primary concern is whether the structure of the proposed model is consistent with the system's current rules and decision-making procedures. Accordingly, a test was carried out to see if the structure of the research model and the organization of export consortia in practice conflicted were compatible. The study professionals acknowledged that the behavior of the variables to improve the export consortium's performance and accomplish the targeted aims is entirely compatible with reality.

TABLE 7. The results of the research model in the short-term and medium-term periods to validate the adequacy of the boundaries test.

Time frame	Year	The performance level of export consortiums in different seasons			
		First three months	Second three months	Third three months	Fourth three months
Short term	2011	0.2	0.234078	0.270659	0.309926
	2012	0.352078	0.397327	0.4459	0.498043
	2013	0.554018	---	---	---
Medium-term	2011	0.2	0.234078	0.270659	0.309926
	2012	0.352078	0.397327	0.4459	0.498043
	2013	0.554018	0.614106	0.678612	0.74786
	2014	0.822198	0.902002	0.987674	1.07965
	2015	1.17838	1.28438	1.39817	1.52033
	2016	0.65147	---	---	---

Extreme Condition test: Here, it should be assessed whether the model exhibits proper behavior and reactivity in the event of unexpected changes in particular parameters. The question of whether a rapid change in the model is apparent over a long time may also be used to study this problem. Accordingly, the sensitivity of the model to these changes was tested by changing the parameter values to very high and very low states. The outcomes demonstrate the model's logical behavior in these circumstances. Furthermore, just the slope or range of the graphs varies with the change in the export consortium's performance, and the behavior of the model is not sensitive to this change. Besides, the research model was used for 50 years before any abrupt behavior or alterations were noticed. This demonstrates that, in terms of the end conditions, the research model is valid.

Partial tests of model components: After breaking the model down into smaller, simpler sub-models for this test, each of the sub-models underwent the boundary behavior test before being added to the main model.

Surprise Behavior: Is the study model capable of producing unusual, weird, and undetected behavior over the chosen period? The findings show that the study model exhibits no surprise behavior.

Parameter Assessment: Here, the topic of whether the model's parameters and their numerical values are consistent with the system's data is raised. Experts validated the conformity of the model's parameters with reality based on this test. The model parameters include "business of consortium members", "certificate of foreign standards", "efforts to establish cooperation between business institutions of trading countries", "awareness and use of support from incubation centers and export accelerators", "national and international export consultation", "competitive pricing", "creating a team work culture instead of the spirit of individual entrepreneurship" and "improving the quality of existing products". Moreover, these factors' values, which reflect the situation of export consortia at the moment, in reality, were established by specialists.

Parameter Sensitivity Analysis: If there are substantial changes in numerical values, behavior, and consequent policies with changes in parameters, boundaries, and periods, it should be identified in the sensitivity analysis. Thus, three scenarios are suggested to reinforce the research model's parameters and enhance export consortia' performance (Table 8). Because the study specialists think the reinforcements can be executed within 2 years and the outcomes may be employed, these scenarios attempt to strengthen 10% of all model parameters within that time. The first scenario is to demonstrate what happens when all model parameters are strengthened by 10% in 2013. The second scenario aims to demonstrate what happens when all model parameters are strengthened by 10% in 2023 and 2025. The final scenario aims to demonstrate what happens

when all model parameters are strengthened by 10% in 2023, 2025, and 2027. The outcomes of the model parameter augmentation policies based on the three suggested scenarios are displayed in Figure 10 and Table 9, respectively. According to the outcomes of the

scenarios (i.e., 10% strengthening of all model parameters throughout three time periods in 1402, 1404, and 1406), the performance of export consortiums in 2031 under scenarios 1 to 3 can improve by 9.5%, 20.6%, and 27.5%, respectively, over the baseline model.

TABLE 8. The way of applying 10% strengthening policy of all model parameters in 2023, 2025 and 2027

Research model parameters	Parameters 'code	Initial value	Scenario 1 (10% increase in 2023)	Scenario 2 (10% increase in 2025)	Scenario 3 (10% increase in 2027)
Consortium members' experiences	FCMs1	0.6	0.6 + RAMP (0.06, 1402, 1404)	0.6 + RAMP (0.06, 1402, 1404) + RAMP (0.12, 1404, 1406)	0.6 + RAMP (0.06, 1402, 1404) + RAMP (0.12, 1404, 1406) + RAMP (0.18, 1406, 1408)
National and international export consulting	EOP2	0.6	0.6 + RAMP (0.06, 1402, 1404)	0.6 + RAMP (0.06, 1402, 1404) + RAMP (0.12, 1404, 1406)	0.6 + RAMP (0.06, 1402, 1404) + RAMP (0.12, 1404, 1406) + RAMP (0.18, 1406, 1408)
fostering a culture of teamwork rather than a single entrepreneurial mentality	CB1	0.6	0.6 + RAMP (0.06, 1402, 1404)	0.6 + RAMP (0.06, 1402, 1404) + RAMP (0.12, 1404, 1406)	0.6 + RAMP (0.06, 1402, 1404) + RAMP (0.12, 1404, 1406) + RAMP (0.18, 1406, 1408)
Competitive pricing	CB5	0.6	0.6 + STEP (0.06, 1402)	0.6 + STEP (0.06, 1402) + STEP (0.12, 1404)	0.6 + STEP (0.06, 1402) + STEP (0.12, 1404) + STEP (0.18, 1406)
Understanding and using incubation centers' and export accelerators' help	ES2	0.6	0.6 + RAMP (0.06, 1402, 1404)	0.6 + RAMP (0.06, 1402, 1404) + RAMP (0.12, 1404, 1406)	0.6 + RAMP (0.06, 1402, 1404) + RAMP (0.12, 1404, 1406) + RAMP (0.18, 1406, 1408)
Certificate of international standards	TFs2	0.6	0.6 + STEP (0.06, 1402)	0.6 + STEP (0.06, 1402) + STEP (0.12, 1404)	0.6 + STEP (0.06, 1402) + STEP (0.12, 1404) + STEP (0.18, 1406)
Initiatives to foster collaboration between trade countries' business entities	GFs1	0.3	0.3 + RAMP (0.03, 1402, 1404)	0.3 + RAMP (0.03, 1402, 1404) + RAMP (0.06, 1404, 1406)	0.3 + RAMP (0.03, 1402, 1404) + RAMP (0.06, 1404, 1406) + RAMP (0.09, 1406, 1408)
Improving the quality of existing products	PFs1	0.6	0.6 + STEP (0.06, 1402)	0.6 + STEP (0.06, 1402) + STEP (0.12, 1404)	0.6 + STEP (0.06, 1402) + STEP (0.12, 1404) + STEP (0.18, 1406)

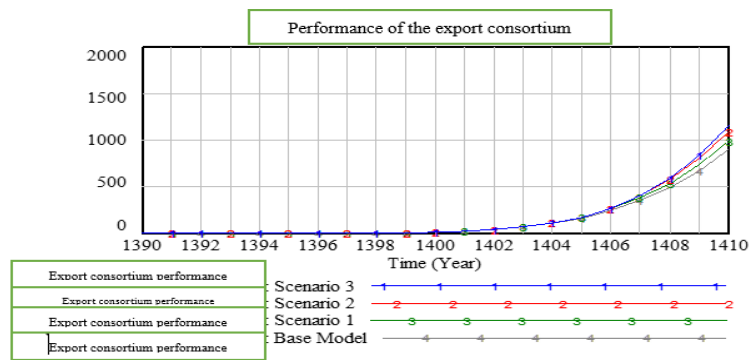


Figure 10. Performance results of export consortia based on three proposed scenarios

TABLE 9. Performance results of export consortia based on three proposed scenarios

Year	Main model	Scenario 1 (10% increase in 2023)	Scenario 2 (10% increase in 2025)	Scenario 3 (10% increase in 2025)
2011	0.2	0.2	0.2	0.2
2012	0.336312	0.336312	0.336312	0.336312
2013	0.512666	0.512666	0.512666	0.512666
2014	0.740848	0.740848	0.740848	0.740848
2015	1.03612	1.03612	1.03612	1.03612

2016	1.41822	1.41822	41822	41822
2017	1.91272	1.91272	1.91272	1.91272
2018	2.86319	86319	86319	86319
2019	4.74533	4.74533	4.74533	4.74533
2020	8.30188	8.30188	8.30188	8.30188
2021	14.6215	14.6215	14.6215	14.6215
2022	25.2407	25.2407	25.2407	25.2407
2023	42.2763	42.2763	42.2763	42.2763
2024	68.596	68.596	68.596	68.596
2025	108.04	110.0629	110.0629	110.0629
2026	165.707	173.2904	173.5811	173.5811
2027	248.327	264.6616	271.7304	271.7304
2028	355.282	382.945	405.131	405.653
2029	493.735	536.0629	577.8181	588.533
2030	672.959	734.2695	801.3565	834.8707
2031	904.956	990.8378	1090.715	1153.537

5. DISCUSSION

Among the various benefits of consortia, the literature review shows increased presence in foreign and international markets, reflecting increased exports, increased business contacts, increased bargaining power, and acquisition of knowledge about markets. A review of studies focusing on consortium case studies confirms the identified benefits. In particular, it can be seen that the internal competencies of the member companies related to internationalization, such as the number of customers abroad and their position in the international market, have improved significantly (43). Of course, it should be noted that many changes are always and the conditions including economic, political, cultural and environmental conditions are also influential in improving or not improving these conditions. For example, the Corona epidemic has been one of the changes and conditions that have had many effects on consortia and other business sectors (44). During the last few years, the effects of this big change have been the basis of many researches. Some researchers investigated the effects of various types of risks and trust in post-pandemic industries (45). Many researches have also been done on supply chains and the effects of intelligence on the supply chain of small and medium businesses after the corona virus pandemic. In this regard, some researchers proposed specific management strategies to manage supply chains after the pandemic (46). Therefore, it can be seen that the Corona pandemic has many effects on the export and import of products in small and medium-sized companies. For this reason, in this research, an effort has been made to investigate the role of consortia in the export of small and

medium companies by presenting a fuzzy dynamic model. Of course, many other approaches have been used in the literature. For example, some researchers have used meta-heuristic methods and evolutionary optimization methods such as particle swarm to solve models. These researchers have used these innovative and meta-heuristic methodologies for their allocation and placement models. But by reviewing the literature, we can see that one of the best methods is the dynamic modeling method, which is discussed in this research.

According to the findings, "features of consortium members," "export operational plan," "consortium strengthening factor," "recognition of export support," "transnational factors," "governmental factors," and "product features" are the seven main success factors of private sector export consortia in Iran's industries. For the establishment of private sector export consortiums in Iranian industries, the following eight procedures were established: 1. choosing an appropriate promoter, 2. Finding potential participants, 3. Carrying out interest research and contacting possible participants. 4. Selecting representatives. 5. Organizing meetings with prospective participants. 6. Carrying out a feasibility study and creating a business plan 7. Formally establishing a collaboration. 8. Monitoring consortium activities.

The results show that a hazy strategic map was created for the major elements that contributed to private sector export consortia's performance in Iranian industries, and "features of the consortium members" was identified as the most important and determining element. In the fuzzy cognitive map, the terms "export operational program," "transnational factors," and

"product features" each have the maximum axial indices. The findings indicated that the fuzzy dynamic model for private sector export consortia in Iranian industries comprises seven rate variables (current) that are crucial to export consortia success and one state variable (inventory) titled "performance of export consortia."

6. CONCLUSION

Researchers can draw inspiration from the subject of this study and other statistical and decision-making techniques and tools to conduct studies such as compiling guidelines for export consortia based on the key success factors identified in various industries, designing consortia maturity models, and offering an export excellence model to help export consortia perform better.

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**Persian Abstract****چکیده**

نبود کنسرسیوم های صادراتی فعال و نبود برنامه فنی، جدی و مدون برای توسعه آنها از مهم ترین دلایل باقی ماندن بنگاه های کوچک و متوسط ایران در مختصات صادراتی کشور است. در این پژوهش، داده ها با رویکرد ترکیبی (کیفی- کمی) که یک پارادایم انتقادی است، جمع آوری و تجزیه و تحلیل می شود. داده ها با استفاده از روش تحقیق کتابخانه ای و میدانی گردآوری شده است. در بخش میدانی از مصاحبه های ساخت یافته، اکتشافی و مشارکتی در مرحله کیفی و از پرسشنامه های محقق ساخته در مرحله کمی استفاده می شود. داده ها با استفاده از نظریه زمینه ای، جلسات طوفان فکری، نقشه شناختی فازی (FCM)، سیستم استنتاج فازی (FIS) و مدل سازی دینامیک سیستم (SDM) تجزیه و تحلیل می شوند. بر اساس نتایج، «ویژگی های اعضای کنسرسیوم»، «برنامه عملیاتی صادرات»، «عامل تقویت کنسرسیوم»، «شناخت حمایت از صادرات»، «عوامل فراملی»، «عوامل دولتی» و «ویژگی محصول» هفت گانه اصلی هستند. عوامل موفقیت کنسرسیوم های صادراتی بخش خصوصی در صنایع ایران. همچنین شناسایی مروج مناسب، شناسایی اعضای بالقوه، انجام مطالعه مورد نظر و تماس با شرکت های ذینفع، تعیین نمایندگان، برگزاری جلسات بین اعضای احتمالی، انجام مطالعات امکان سنجی و تهیه طرح تجاری، تشکیل رسمی کنسرسیوم و پیگیری امور کنسرسیوم. هشت گام برای ایجاد کنسرسیوم های صادراتی بخش خصوصی در صنایع ایران است.