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Developing the Framework of Entrepreneurship Education Ecosystem in Iranian Schools Using Soft System Methodology

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A B S T R A C T

This qualitative study aims to develop the framework for the entrepreneurship education ecosystem in Iranian schools. This study developed the ecosystem framework for entrepreneurship teaching in schools using Soft Systems Methodology. The Soft Systems Methodology is employed in a problematic situation that necessitates improvement. In the entrepreneurship education ecosystem of Iranian schools, the educational structure is unfavourable, and the students' entrepreneurial capacities have not been realized, so soft systems methodology was used to improve these conditions. This study adopted a methodology with seven processes, five of which are carried out in the real (physical) world, and three involve system thinking and the human mental world. The problematic situation of entrepreneurship education in schools was determined using Soft Systems Methodology, and the actors and relationships were designed. The conceptual models corresponding to the main actors were obtained from the interviews with the actors in this field. Finally, by combining models, the integrated model of developing the framework of the entrepreneurship education ecosystem in Iranian schools was obtained. Then, necessary actions to realize this desired model were brought from the perspective of each of the actors. The development of a structure by the Ministry of Education to establish offices of industries and start-ups in schools to involve students in entrepreneurial activities has been accomplished to achieve the desired model. This study has educational, theoretical, and policy benefits for entrepreneurship education in Iran and the world. The supporting elements of entrepreneurship education in Iranian schools and the essential strategies were described. The present study's academic contribution lies in developing the entrepreneurship education ecosystem, examining how its components interact, and identifying the necessary actions for each.

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1. Introduction

Entrepreneurship is an element in economic and social development due to its positive effect on innovation, competitiveness, and job creation (Luis-Rico et al., 2020). The role of entrepreneurship in accepting significant social challenges (Rae, 2010) has turned entrepreneurship education into a tool for empowering people and organizations to create social value for public benefits (Wilson et al., 2009). Also, entrepreneurship education is considered a tool to achieve a knowledge-based economy and deal with economic and social problems (Abdullah et al., 2009; Molaei et al., 2014; İlhan Ertuna and Gurel, 2011). Entrepreneurship training enables people to acquire the necessary skills to discover business ideas and introduce products or services to the market (Kimwolo et al., 2012). The goals of entrepreneurship education include acquiring knowledge in entrepreneurship, developing entrepreneurial skills, and developing personality traits, e.g., leadership or initiative (Breen, 2004). More knowledge about entrepreneurial skills and different aspects of entrepreneurship will help to have a realistic understanding of entrepreneurial activity (Ajzen, 2002).

Also, universities have developed entrepreneurship by teaching the knowledge and skills necessary to start and manage businesses (Wang et al., 2019). Many experts believe developing young people's entrepreneurial attitudes and skills should begin at school (Axelsson et al., 2015). Globally, experts assess the state of business education in schools as very low (Peña-Legazkue et al., 2019). Due to inefficient and traditional school curricula, young people do not communicate with necessary issues and topics. It makes students incapable of using available opportunities to strengthen creativity. To address these inefficiencies, a recommended course of action is to modify the curriculum structure (Hosseinikhah, 2002). In a traditional curriculum, special attention is mainly paid to theoretical topics, and students face practical and experimental issues less, so students only memorize the educational content. However, to teach entrepreneurship according to its nature, it is necessary to use educational methods that strengthen creativity in students and are based on practical work (Gibb, 2002).

Old and purely theoretical methods in entrepreneurship education cannot efficiently prepare students for entrepreneurship.. New educational methods should be used (Birami Erdy et al., 2019) to take advantage of new models of entrepreneurship education and nurture creative and innovative students as future entrepreneurs. (Mehrabi, 2017). According to the prevailing educational structure in Iranian schools, students are less likely to do entrepreneurial projects and practical actions (Vathghi, 2011). Therefore, the spirit and attitude of entrepreneurship have

yet to be significantly developed in students, and every year many students graduate without entrepreneurial skills (Qurbani, 2016).

In the existing educational structure, most entrepreneurship teachers lack an entrepreneurial mindset and attitude, and thus, they cannot make students interested while teaching entrepreneurship (Ork and Mahmudi-Bardzardi, 2015). Also, the communication between teachers and students is one-way, and it is impossible to challenge and encourage students to take entrepreneurial actions (Mohammadi, 2008). In the past years, entrepreneurship education has been noticed in Iranian schools, and changes have been made in the entrepreneurship education program. However, previous studies indicate that these changes are insufficient and need to review various dimensions of entrepreneurship education in Iranian schools (Fallah Haghighi et al., 2018). It has been demonstrated in previous studies (Ahmadpour Karimabadi, 2021; Hashemi et al., 2021; Yar mohammadzadeh et al., 2019; Omidi et al., 2018; Rezaei, 2019; HajiAghaee, 2019; Abolhasani, 2019; Mehrabi, 2017) that the current curriculum has been ineffective in nurturing an entrepreneurial spirit in learners. Furthermore, the educational system needs a clear plan to enhance student entrepreneurship. With this inefficient curriculum, schools do not have the required efficiency to train entrepreneurial and creative students (Yar mohammadzadeh et al., 2019).

Previous investigations show that measures taken by the Iranian educational system to teach entrepreneurship in schools could have been more effective and responded to the needs of society. In this regard, the officials and curriculum planners should consider an education program considering all aspects of entrepreneurship education. Therefore, research is necessary to develop a framework for the entrepreneurship education ecosystem in Iranian schools.

2. Literature review

The main goal of most entrepreneurship education is to develop entrepreneurial competencies (Lackéus, 2014). Entrepreneurship is usually created in early education, mainly through entrepreneurial projects. For example, student-led practical projects are done by producing goods, providing services, or organizing school events (Pelletier, 2007). Entrepreneurship projects are not used to teach how to start a business but to develop students' attitudes (Pelletier, 2007). Three educational goals are identified in the entrepreneurship literature (Breen, 2004):

(1) Gaining entrepreneurship knowledge to understand the phenomenon better. (Entrepreneurship as a learning content to be taught (knowledge)).
(2) Developing specific entrepreneurial skills to become an entrepreneur (Entrepreneurship as a job activity (skill)).

(3) Developing key personality traits, such as leadership and initiative, is crucial in fostering an entrepreneurial mindset (Entrepreneurship is a process through which a person develops a personality (attitude)).

Business education methods include forms of cooperation in coproduction, i.e., business environments in formal educational processes (Floris and Pillitu, 2019) or direct communication with business environments through projects (Hebles et al., 2019). Also, one recommendation is to include learning by acting as a vital part of education (Gibcus et al., 2012). Some educational approaches are problem-based learning (San Tan and Ng, 2006), project-based learning (Jones and English, 2004), and service-learning (Desplaces et al., 2009). Project-based learning allows students to work on a specific problem and create an "artifact" to solve it, i.e., a final product, such as a report, a model, or a video (Blumenfeld et al., 1991). Problem-based learning begins with a specific problem and ends with discussing possible solutions and further guidance (Helle et al., 2006). Service learning is classroom learning integrated with community service (including cleaning parks, visiting the older people, and providing food for those in need) (Spring et al., 2008). In Table 1, a comparison has been made between educational approaches and similarities and differences between entrepreneurial education with other educational approaches.

Table 1. Similarities and differences between entrepreneurial education and other educational approaches (Lackéus, 2015).

Most focus on:	Entrepreneurial education	Problem-based learning	Project-based learning	Service-based learning
Issues	X	X	X	X
Opportunities	X			X
Accuracy	X	X	X	X
Production of handicrafts	X		X	
Repeated experiences	X			
Actions in real world	X			X
Creating value for external stakeholders	X			X
Group work	X	X	X	X
Working for a long time	X		X	X
Newness/innovation	X			
failure risk	X			

2.1. Research background

The previous research on developing entrepreneurship education in schools will be reviewed here. The authors have proposed methods, approaches, and tools to improve school entrepreneurship education in these studies.

Luis-Rico et al., (2020) showed that practical aspects of entrepreneurship should be taught to students through expert stakeholders. They also showed that project-based learning methods

based on collaborative learning and service-based learning based on developing social and ethical entrepreneurial spirit suit entrepreneurship education. Sai et al., (2019) investigated the entrepreneurial skills of urban youth and created a model for entrepreneurial skills for Chinese youth. It analyzed 526 students aged 14 to 18 from four secondary and high schools. The findings showed that entrepreneurial skills are still average. Visiting to famous local companies, lectures by successful entrepreneurs to share experiences, and financial literacy and knowledge in personal finance are some of the most practical matters in learning entrepreneurship. Winarno et al., (2019) presented a model for entrepreneurship education through cooperation between high schools and SMEs in East Java. In this model, companies can hire graduates of vocational schools based on their needs. These schools can place them as their partners for cooperation in improving knowledge and curricula.

According to the recommendation by Chiloane-Tsoka (2016), the integration of entrepreneurship into education should commence at the elementary school level and continue through secondary school. Schools should collaborate with organizations like banks to create educational materials focusing on financial skills and competencies. It is recommended that high-school students have some work experience in the industry. This experience allows students to develop their skills beyond the classroom and boost their confidence before entering the business world. Zivkovic et al., (2015) investigated games' impact on developing creativity and innovation in schools. Using the Doris tool showed that imaginative games could create interest in expressing creativity, build self-confidence and strengthen creative thinking. Participants were allowed to express their ideas. The "Danish Foundation for Entrepreneurship-Young Enterprise" presented a development model, including four basic dimensions to be considered by teachers: (1) Entrepreneurship education should be based on students' practical actions in the form of teamwork, aiming to create value for others. (2) In this education, students should use their creativity to test their ideas and find new solutions with knowledge. (3) Entrepreneurship education should interact with the environment outside the school or university and interact with the culture, market, and professional actors of the society and learn from them. (4) Finally, it is necessary for entrepreneurship education to pay attention to attitudinal aspects like belief in one's ability, tolerance of uncertainty, and the risk of failure. These four basic dimensions are useful for all teachers who are developing new teaching content, teaching processes, and forms of assessment and examinations (Rasmussen and Nybye, 2013).

Huang et al., (2017) investigated the STEM-Inc project as an extracurricular program in high school. It includes a technology business incubator implemented in an after-school

program for junior high school students in several high schools in California. The purpose is to raise awareness among high school students and their parents regarding the available career paths in Science, Technology, Engineering, and Mathematics (STEM) while fostering student engagement and interest in these fields and related occupations. This project showed two aspects of engineering and business to the students. First, the engineering aspect is where students identify a real-world problem and look for a practical solution that requires engineering design, assembly, and testing. Second, the business aspect is where students learn the business value of the product chosen for a target market and look for ways to improve it by creating new business. Students formed teams of 3 to 6 people and shared common ideas. During this process, they learned various steps to design and build a business and moved towards creating prototypes. Students reported that learning skills like identifying connections between mathematics, science, and engineering result from the project activities. They learned several business and entrepreneurial skills from it. Barma et al., (2017) describe the experimental process of creating a hybrid activity between school and work and show how 9th to 11th-grade students enrolled in a general education program experienced entrepreneurship in a project called FAST. It responded to a call for proposals from Quebec province officials in eastern Canada, emphasizing joint action and collaboration between researchers and school partners to increase student sustainability and educational achievement. This experimental process also included agreements between schools and businesses so that young people could choose more freely when they attend classes and work. Through this, high-school students can start their own business at school. Table 2 presents a summary of the research background.

Table 2. A summary of research background

Researcher	Research title	Findings
Luis-Rico et al., (2020)	Entrepreneurial Interest and Entrepreneurial Competence Among Spanish Youth: An Analysis with Artificial Neural Networks	Using project-based learning (based on cooperative earning) and service-based learning (based on developing social and moral entrepreneurial spirit) methods. Practical aspects of entrepreneurship should be taught to students through expert stakeholders to increase their intention.
Sai et al., (2019)	A model for youth entrepreneurship skills of the community-based leadership training for the urban youth in China	Three important activities for entrepreneurship education: 1. Visiting famous local companies. 2. Successful entrepreneurs give lectures to share their experiences with young people. 3. Financial literacy and personal finance activities.
Winarno et al., (2019)	Integration of vocational school and Small-Medium Enterprises (SMEs) learning: An effort of elevating entrepreneurship spirit	The working relationship of high-school or vocational school students with SME companies improves students' entrepreneurial skills and attitudes. These companies can be good partners for schools in improving knowledge and curricula.

Researcher	Research title	Findings
	based on strength and weakness in East Java	
Chiloane-Tsoka (2016)	Factors influencing the perceptions of youth entrepreneurship development in South Africa	Teachers need to be trained in entrepreneurial and business skills. To develop entrepreneurial financial skills, schools can cooperate with other institutions like banks to create educational materials focusing on financial skills and competencies. High-school students can experience working in industry for a while in their education. Educational institutions can introduce a mentorship approach to help students cooperate practically in entrepreneurial investments.
Zivkovic et al., (2015)	Fostering creativity by a specially designed Doris tool	Games are utilized as an educational method to foster the development of creativity and innovation. Using the Doris tool indicated that an imaginative game can foster interest in expressing creativity, building participant confidence, and reinforcing creative thinking.
Rasmussen and Nybye., (2013)	Entrepreneurship Education: Progression Model.	Entrepreneurship education should be based on students' practical actions, where they work in teams that create value for others.
Huang et al., (2017)	Using business entrepreneurship practices to engage middle school students in STEM learning: Three years' perspective	Taking part in a business 'incubator' in an after-school program, including two aspects: engineering and entrepreneurship. Doing projects to create solutions for real-world problems, including engineering, computer science, and business concepts.
Barma et al., (2017)	Early stages in building hybrid activity between school and work: the case of PénArt	Setting up a business for students in school and producing and selling products by them. Using cooperative education method. The participation of students in entrepreneurship competitions is encouraged.

Each study had a different perspective regarding entrepreneurship education in schools and did not adopt a comprehensive approach. None of the researchers attempted to understand it comprehensively and did not use Soft Systems Methodology as an appropriate methodology to improve the problematic situation. Therefore, using Soft Systems Methodology, this study examines all aspects of entrepreneurship education in schools, identifies all actors in this field, and defines necessary actions.

3. Method

Education in the entrepreneurship field has multiple aspects (such as economic, cultural, social, and moral), making it a complex and difficult field (Bacigalupo et al., 2016). This complexity partly explains the problem of reaching a consensus about the entrepreneurship education model. Therefore, various educational models have been proposed (Bernal-Guerrero et al., 2020). Due to the shortcomings in the entrepreneurship educational system, researchers have proposed different educational methods for entrepreneurship education (Linton and Klinton, 2019). Therefore, this study uses soft systems methodology to improve this problematic

situation. People face social events and incidents that require deliberation. In soft systems methodology (SSM), such conditions are considered problematic situations that need improvement. This methodology has seven steps, five occurring in the real world and three in the human mental world with systemic thinking (Checkland and Poulter, 2020).

Step 1: Understanding the problematic nature of the situation
It is done in the real world; only the situation should be identified.

Step 2: Description of the situation of the problem
The researcher uses rich pictures to show essential views of the situation, administrative processes, and existing structures. The rich picture shows the contradictions and differences in the problematic situation (Checkland and Poulter, 2020).

Step 3: Root definition
In this step, the researcher enters the systems world (Checkland and Haynes, 1994). They express root definitions by using main viewpoints regarding the situation. Root definition describes the desired system and seeks to define the goals and participants. Using Clients, Actors, World view, Owners, and Environment (CATWOE) analysis, the obtained root definitions can be completed. In CATWOE analysis, the researcher aims to identify customers, actors, transformation process, worldview, owners, and environment to enrich the root definitions by using them (Checkland and Poulter, 2007). In Table 3, the definition of CATWOE analysis elements is discussed.

Table 3. The definition of CATWOE analysis elements is discussed.

Title	Definition
Customers	Victims/beneficiaries of conversion
Actors	Members doing the conversion
Transformation	What is transformed by the system
Worldview	What gives meaning to transformation
Owners	Members who can stop the transformation
Environment	Limitations that can affect the system

Step 4: Conceptual model
The researcher seeks to create a conceptual model using root definitions and system rules. The resulting conceptual model includes different views on the issue, which shows a consensus.

Step 5: Comparing the conceptual model with the real world
Here, the researcher compares the obtained conceptual model with the actual world to see possible differences (Checkland and Winter, 2006).

Steps 6 and 7: Identifying desirable and possible changes and taking action

The researcher seeks to find changes to improve the system. These changes should have desirability and possibility simultaneously (Checkland, 1994). Next, the changes should be implemented. An operational plan must be adjusted first (Checkland and Winter, 2006).

3.1. Reliability and validity

The researcher's consideration increases the credibility of the study, accurate question formulation, monitoring of the interview process, data collection, and information analysis (Riege, 2003). Data collection up to saturation, adopting a specific, transparent procedure for selecting sentences, coding, and analyzing them improved transformability (Riege, 2003).

To conduct Soft System Methodology, it was imperative to gather perspectives from managers, teachers, and experts in entrepreneurship education. Therefore, targeted interviews were conducted with experts and specialists familiar with various dimensions of entrepreneurship education in schools. Semi-structured interviews were used to understand the situation of the problem and to find different worldviews regarding the way of teaching entrepreneurship in schools. Considering the researcher's familiarity with this field and the research objectives, selected experts qualified to answer were interviewed. Here, sampling was done purposefully. Characteristics of the participants are given in Table 4;

Table 4. Characteristics of participants in investigating the inefficiency of current state of entrepreneurship education in schools

No.	Responsibility	Area of expertise
1	Principal	Educational management
2	General manager of the Ministry of Education	Curriculum design
3	University professor in entrepreneurship education	Entrepreneurial research
4	University professor in entrepreneurship education	Entrepreneurial research
5	Entrepreneurship mentor	Guiding students in the field of business
6	Member of Parliament	Policy-making
7	Industry manager	Management of big industries
8	Start-up manager	Management of knowledge-based company
9	Students' parents	Start-up business
10	Students interested in entrepreneurship	Entrepreneurial projects

The interview questions were designed according to the review of previous studies. Interviews were conducted deeply and in a semi-structured format. The details of the interview protocol are given in Table 5.

Table 5. The structure of conducting the interview

Question group code	Question code	Sub-question code	Questions
CRQ1			**Students' participation in and support of entrepreneurial activities in school**
	TQ1		Which voluntary people and groups support entrepreneurship education in schools?
		IQ1	How do volunteers support entrepreneurial activities?
		IQ2	What equipment do volunteers provide for students?
CRQ2			**Methods of entrepreneurship education in schools**
	TQ1		Explain common methods of entrepreneurship education in Iranian schools.
	TQ2		Do Iranian schools have new methods for entrepreneurship education based on experiencing entrepreneurial activity and being in entrepreneurial situations?
CRQ3			**Assessment and evaluation of entrepreneurship education in schools**
	TQ1		Is the students' interactions a basis for teachers' evaluation?
		IQ1	Is the evaluation done based on how much external stakeholders are satisfied with the students?
		IQ2	Is the evaluation done based on whether students have learned something from external stakeholders or not?
		IQ3	Is the evaluation done based on the quality of students' homework (e.g., creating value for others)?
CRQ4			**Entrepreneurial learning outcomes in schools**
	TQ1		How is the students' theoretical knowledge reinforced in entrepreneurship education?
	TQ2		What skills are reinforced in students regarding entrepreneurship?
	TQ3		What insights and attitudes are reinforced in students after entrepreneurship education?
CRQ5			**The way of timing entrepreneurship education**
	TQ1		Are entrepreneurship classes held weekly?
	TQ2		Is entrepreneurship education done during different subject?
	TQ3		Are entrepreneurial activities done as extracurricular activities in school?
	TQ4		Is enough time allocated to discussions about entrepreneurship education among teachers?
CRQ6			**Educational infrastructure**
	TQ1		Do they use effective, capable mentors of the entrepreneurship field?
	TQ2		Does the principal support entrepreneurship education enough?
	TQ3		Does the school have enough supportive environment for entrepreneurship education?
CRQ7			**Curriculum design**
	TQ1		Is curriculum design based on the needs of different parts of business?
	TQ2		Do the students cooperate in choosing the method of entrepreneurship education?
	TQ3		How does curriculum help to train entrepreneurial people?

4. Results

4.1. Steps 1 and 2: Knowing the situation of the problem

The resulting rich picture was drawn in Figure 1 after conducting semi-structured interviews and analyzing the answers. This diagram shows key actors in entrepreneurship education, their interactions, and difficulties and factors. Standard signs have been used to draw a rich picture, described in Table 6.

Table 6. General guide to rich picture

Row	Figure	Explanation
1	Small rectangle	Main actor, secondary actor, entrepreneurship education process
2	Large rectangle	Close environment
3	Arrow sign	The relationship between the actors and their activities towards each other and their role in entrepreneurship education (the direction of the arrow is meaningful)
4	Cloud picture	Roles and duties expected from the actor

4.1.1. Description of the rich picture

The Ministry of Education is among the key actors in school entrepreneurship education. It has a key role in formulating and executing educational policies in entrepreneurship. The problem situation shows that no appropriate educational content has been designed and formulated according to the current needs of society. Also, this Ministry has taken no effective action to train and use teachers having entrepreneurial views and approaches. Some of the goals of this Ministry are: training an entrepreneurial generation, training the human resource, and decreasing social issues such as poverty. Among its goals, the Ministry aims to enhance the organization's position at a global level and improve the quality of educational services.

Schools are another key actor in entrepreneurship education, in charge of executing educational programs and evaluating the number of students' achievements. Schools can carry out entrepreneurship education by creating appropriate educational contexts, allocating time and classrooms, and employing entrepreneurship education. In the current situation, entrepreneurship education has a lower priority for schools than other fields. Generally, schools allocate the time of entrepreneurship courses to other courses, or if they hold this course, they just focus on theoretical aspects.

The other vital actors are the students' parents. Parents can help improve their children's status in entrepreneurship by following their children's educational status and having financial and non-financial support. Since being accepted into university is a top priority for students, entrepreneurship education is unimportant for parents who support their children just to be accepted into universities. As the most significant actors, students have essential tasks. They need to reinforce and develop their knowledge and skills and raise their potential to set up a business in the future. They need to participate in entrepreneurship education programs actively and do their tasks and assignments carefully. Regarding the weakness of entrepreneurship programs at schools and not using new teaching methods in this field, students do not have enough motivation to do entrepreneurial activities.

Industries, start-up companies, science and technology parks, and accelerators are vital actors. Using the existing potentials of these actors can increase the efficiency of curriculum execution. They can also share their facilities, knowledge, and experiences with students to improve their knowledge, skills, and attitudes toward becoming entrepreneurs. Many potentials have yet to be used in the current situation due to the weak connection between these actors and the country's educational system.

The Islamic Consultative Assembly is also one of the critical actors in enacting necessary laws and allocating the required budget and credit in this field. Developing the entrepreneurship ecosystem requires formulating and enacting supportive laws so all actors can use their maximum potential. Also, allocating a sufficient budget is one of the crucial needs in entrepreneurship to achieve the depicted goals.
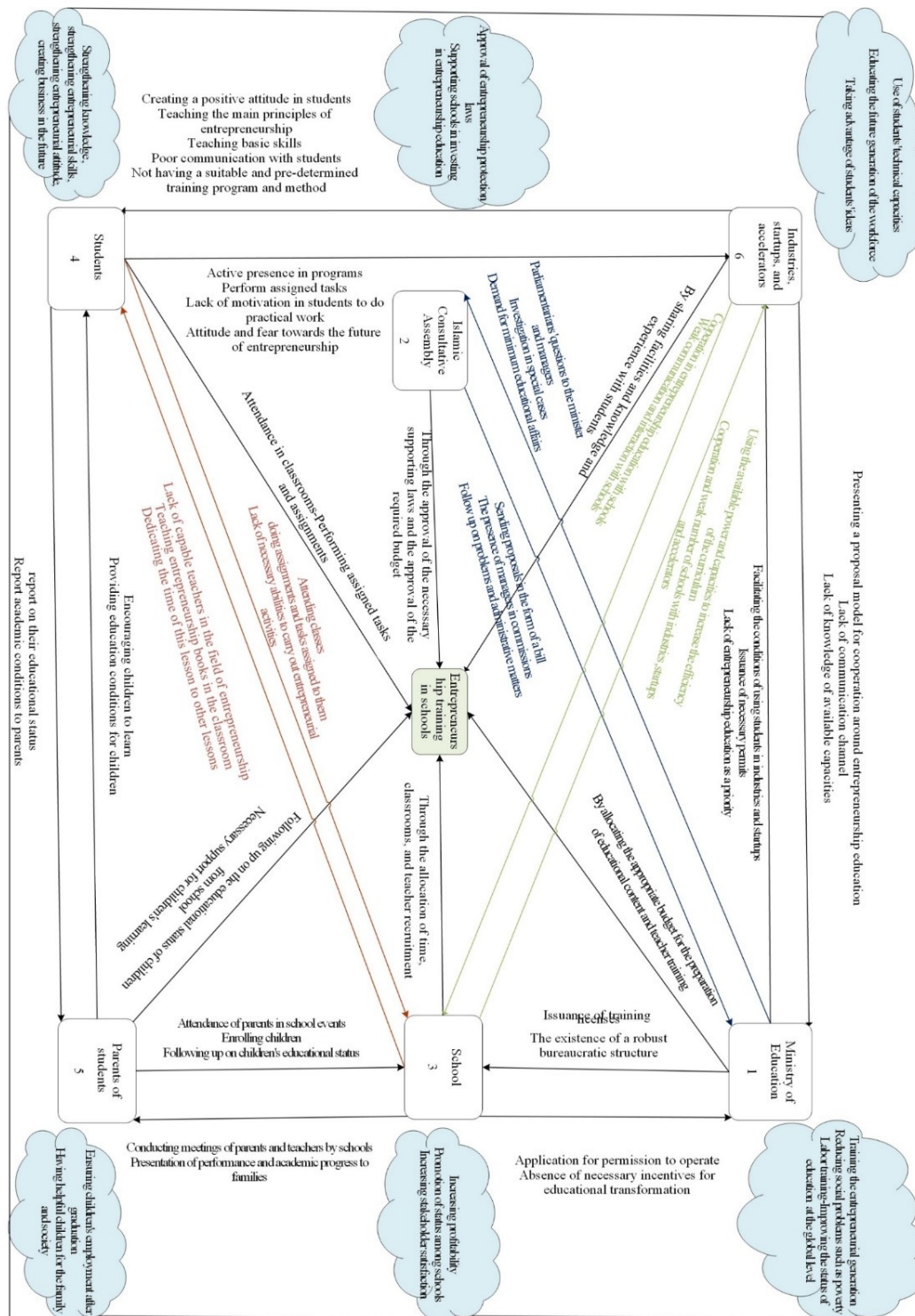
Figure 1. Rich picture

4.2. Step 3: Providing root definitions

Here, root definitions have been formulated and elaborated. Table 7 describes the elements of CATWOE, standing for Customers, Actors, Transformation, Worldview, Owner, and Environment.

Table 7. General guide to rich picture

Actor	Customers (C)	Actors (A)	Transformation (T)	Worldview (W)	The owner (o)	Environment (E)
Islamic Consultative Assembly	*Government *Ministry of Education	* Ministry of Education * Government * School management unit	* Enact protective laws * Supervise the implementation of the promulgated rules	* Reducing backwardness compared to other countries * Creating and strengthening the driving force of entrepreneurship in society	*Government	*Lack of proper infrastructure in the country * Topics related to implementation costs
Ministry of Education	* School management unit * School owners	*Parliament * School management unit	* Examining the status of entrepreneurship education in the country and the world and communicating the necessary instructions to schools * Prioritizing entrepreneurship education	* Creating a spirit of creativity and dynamism in students * Training the entrepreneurial generation	*Government	*Insufficient financial resources *Lack of expert and efficient teachers *Attitude of schools towards entrepreneurship course
School management unit	*Ministry of Education *School owner *Students *Parents of students	* Ministry of Education *The owner	* Preparing conditions in the school * Taking advantage of new methods of entrepreneurship education * Supervising the performance of the teaching staff	* Improving the level of the school among other schools * Developing entrepreneurship dimension in students * Creating profitability for the school	*Owner of the school * Ministry of Education	*Need a lot of time for practical training * The high cost of providing infrastructure *Lack of expert teachers in this field

Actor	Customers (C)	Actors (A)	Transformation (T)	Worldview (W)	The owner (o)	Environment (E)
Industries, startups, science and technology parks, and accelerators	*Schools *Students	. Ministry of Education *Students *Schools	* Providing physical capacities * Sharing knowledge and experience * Creating an entrepreneurial attitude in students	* Utilizing the capacities of students towards their goals.	*Ministry of Education *Schools	* Time limit for the presence of students in the learning environment. *Limited budget to provide facilities * Low cultural level and attitude of parents of students in this area.
students	*School management unit *Parents of students	* School management unit * Parents of students	* Active participation in educational programs * Providing suggestions to improve programs	* Acquiring knowledge, skills, and insights necessary in life * Preparing to start your own business after graduation	*Parents of students *School management unit	* Existence of a competitive atmosphere of passing percentage in the national entrance exam among schools * Downplaying the importance of this lesson in school
Parents of students	* School management unit *Students	* Students * School management unit	* Follow up on the educational status of children from school * Active presence in the Parents and Teachers Association * Supporting and encouraging students to participate in entrepreneurship programs	* Reducing children's job concerns after graduation * Raising creative and entrepreneurial children	*School management unit	* Low cultural level and low knowledge of parents of students in this area. Parents of * students are very busy

4.3. Step4: Model making

Conceptual models in entrepreneurship education drawn in figures 2 to 8 using standard signs:

- A big circle with continuous lines: (main actors).
- A small circle with continuous lines: (activity/secondary actor).
- Circle shape with discontinuous lines: (ecosystem).
- Arrow sign: (connection and continuity of activities, the direction of the arrow indicates the sequence of events)

4.3.1. The islamic consultative assembly (ICA or parliament) model

The ICA Model consists of five stages, depicted in Figure 2. In the first stage, the ICA conducts research and gains information regarding the topics through ICA Research Center. It also investigates universal legislative experiences and evaluates strong and negative points. In this stage, ICA receives suggested bills through communication and interaction with the Ministry of Education and reviews them. Furthermore, there are regular communications between ICA and Planning and Budget Organization to allocate and enact a sufficient budget.

In the second stage, the vision and expectations of law implementation should be investigated, and optimal goals should be formulated clearly. In the third stage, all aspects of this law are reviewed, and it will be enacted in ICA. Then, it will be proclaimed to the associated institutions to be enforced. As the laws are proclaimed, supervisory mechanisms for the exact enforcement of laws should be determined and formulated. In the final stage, ICA should ask for reports from those institutions and organizations in charge of law implementation.
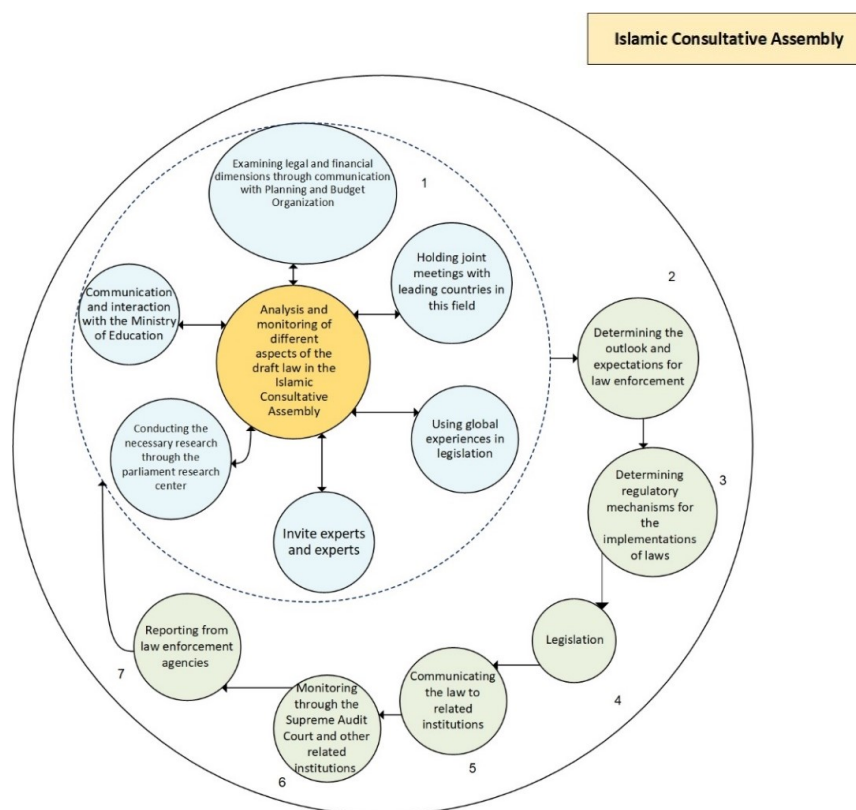
Figure 2. Conceptual model of the support of ICA

4.3.2. The conceptual model of industries, startups, science and technology parks, and accelerators

The conceptual model of industries, startups, science and technology parks, and accelerators consists of seven stages, depicted in Figure 3. In the first stage, representatives of industries,

startup companies, science and technology parks, and accelerators cooperate. It will help investigate cooperation opportunities between the actors, schools, and students. These actors should use the existing potential among students and macro-planning for educating and employing them as future human resources. It should be investigated in detail what services and instructions these actors can provide to reinforce and improve students' technical and non-technical competencies. Studying the universal experiences of the connection between industry and schools and using the researchers' and professors' potential in the country helps design the required structure and processes. The optimal cooperation model should be selected in the next stage regarding all sides' existing conditions, limitations, and expectations. Then, the Ministry of Education should approve the cooperation model and proclaim to those organizations under its supervision. Next, this cooperation should be implemented as a pilot project in several areas. Then, it should be revised and edited using the feedback from selected schools. Afterward, the proposed package should be implemented all around the country. Finally, it should be revised and edited again according to the feedback.
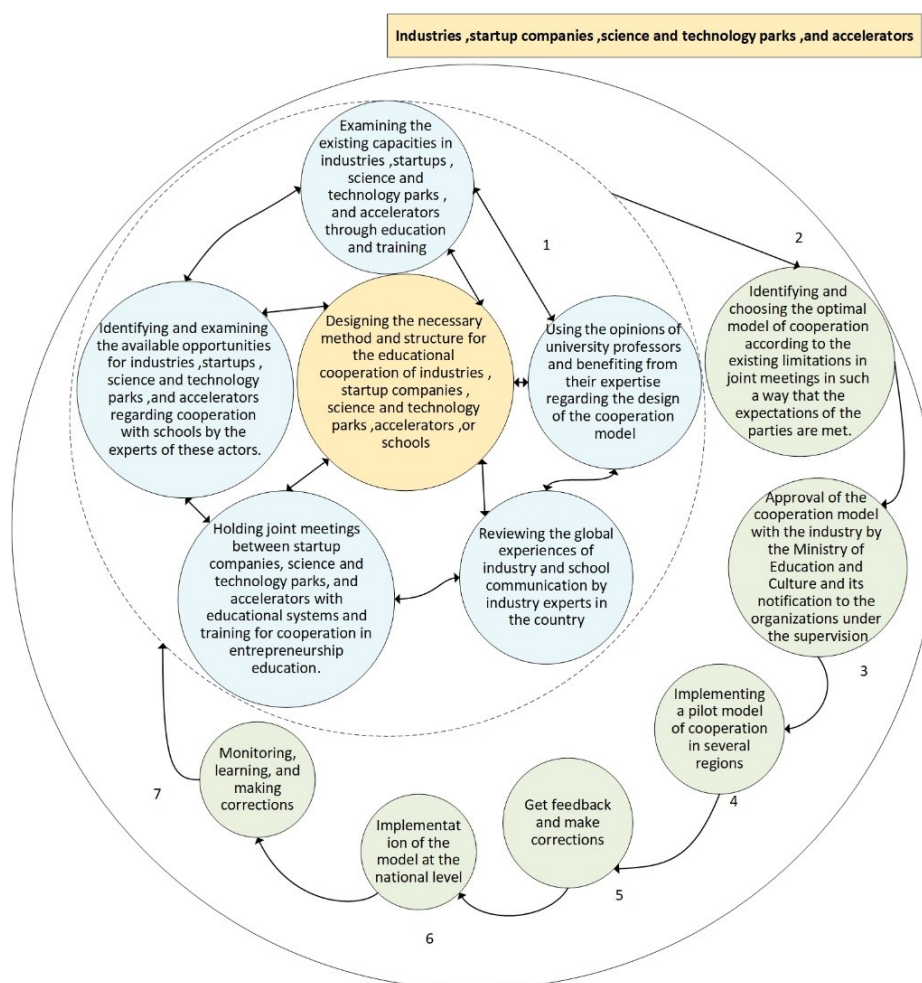
Figure 3. Conceptual model of supporting industries, startups, science and technology parks, and accelerators

4.3.3. *The conceptual model of the ministry of education*

The conceptual model of the ministry of education consists of five steps, depicted in Figure 4. First, different aspects of entrepreneurship education and curriculum should be investigated. It can be carried out in various ways: reviewing the educational models of leading schools (domestic and foreign), receiving the expert teachers' views and recommendations, consulting university professors and researchers in this field, studying the latest research achievements, and cooperating with the ministries of leading countries in entrepreneurship education and using their experiences. Next, findings should be prioritized, rated, and then monitored. The third step consists of two parts. In the first part, the execution mechanism and decision for the intended program should be determined, followed by conducting meetings with the Planning and Budget Organization to secure financing. In the second part, some meetings should be held between the parliament and the Ministry of Education. Afterward, the curriculum should be implemented, and then according to the feedback, it should be revised and edited.
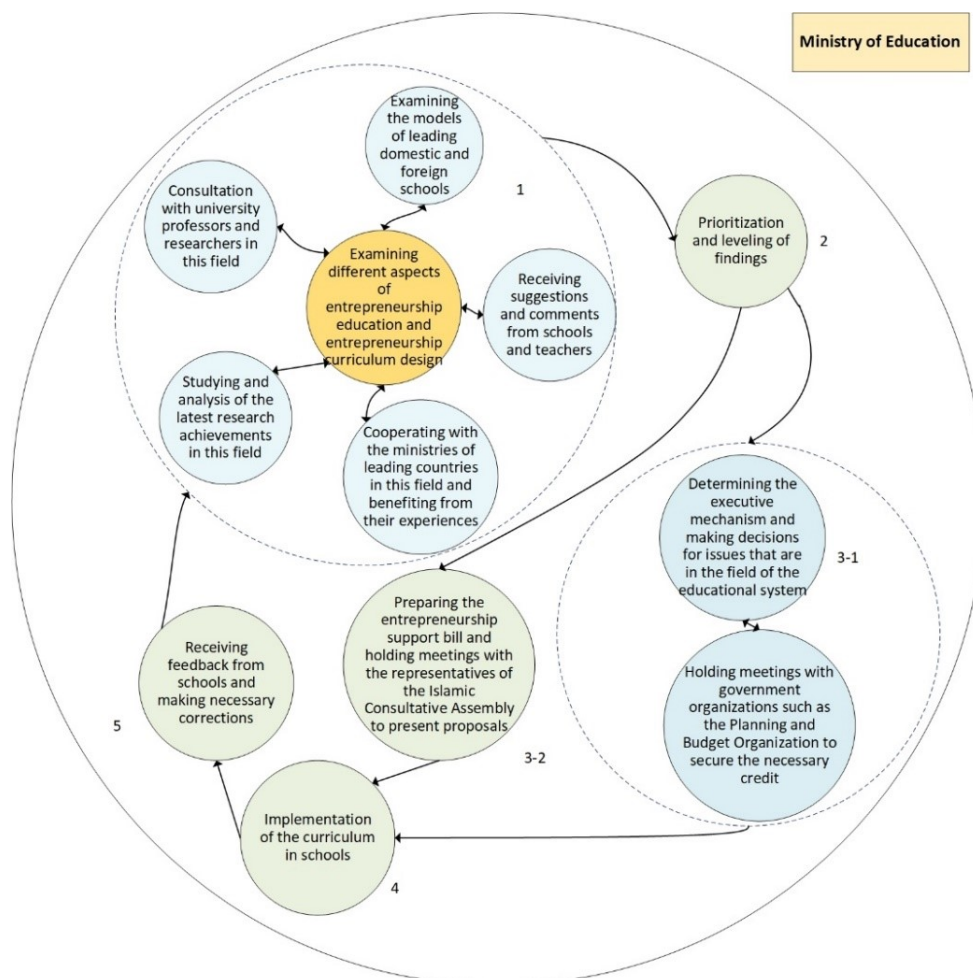
Figure 4. Conceptual model of the ministry of education's support

4.3.4. The conceptual model of schools

The conceptual model of schools consists of five parts, depicted in Figure 5. First, the school starts to identify educational methods, considering its facilities and potential. For this purpose, some actions can be carried out: consulting and cooperating with industries, cooperating with leading centers in entrepreneurship, using the entrepreneurs' potential for entrepreneurship education, using the potential of students' parents, and cooperating with professors and students in entrepreneurship. Second, the proposed solutions and methods should be prioritized based on the existing limitations and resources. Third, there should be a negotiation with stakeholders to execute the entrepreneurship education program and to provide prerequisites for high-quality and practical education. Next, the curriculum will be executed, and finally, monitoring, learning, and necessary revisions in the program will be done. While carrying out the abovementioned processes, the school should check the performance of its rivals so that it can become more prepared to provide educational services.
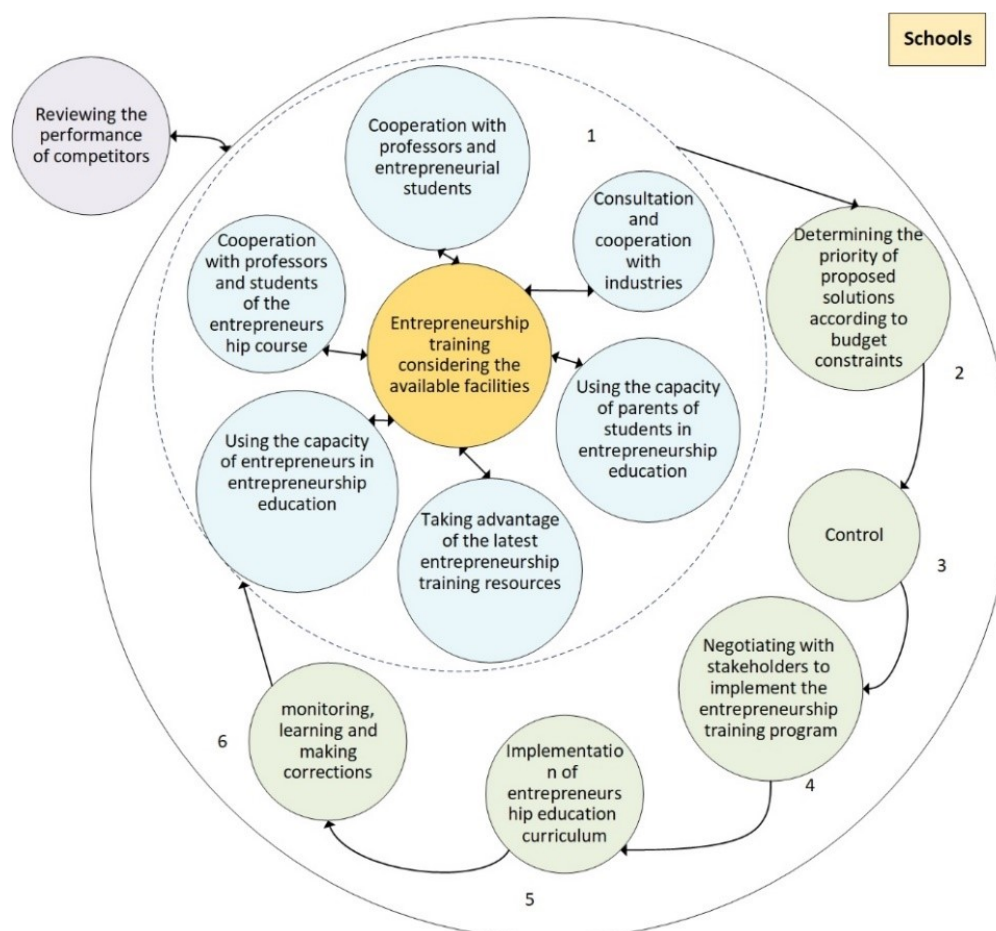
Figure 5. Conceptual model of schools' participation

4.3.5. The conceptual model of students' parents

The conceptual model of students' parents consists of five steps, depicted in Figure 6. First, students' parents can play an effective role in entrepreneurship education and improving the quality of its execution at schools. They can do it through actively participating in school events, offering suggestions to the school management and educational board, giving reports of students' performance outside the school, and providing their potential and social interactions. Second, suggested views and opinions should be summed up with the parent's help. Third, volunteer parents willing to cooperate in entrepreneurship education should determine their roles in helping entrepreneurship education. Next, parents should cooperate and participate in executing educational programs. Eventually, the results should be evaluated and revised wherever necessary.
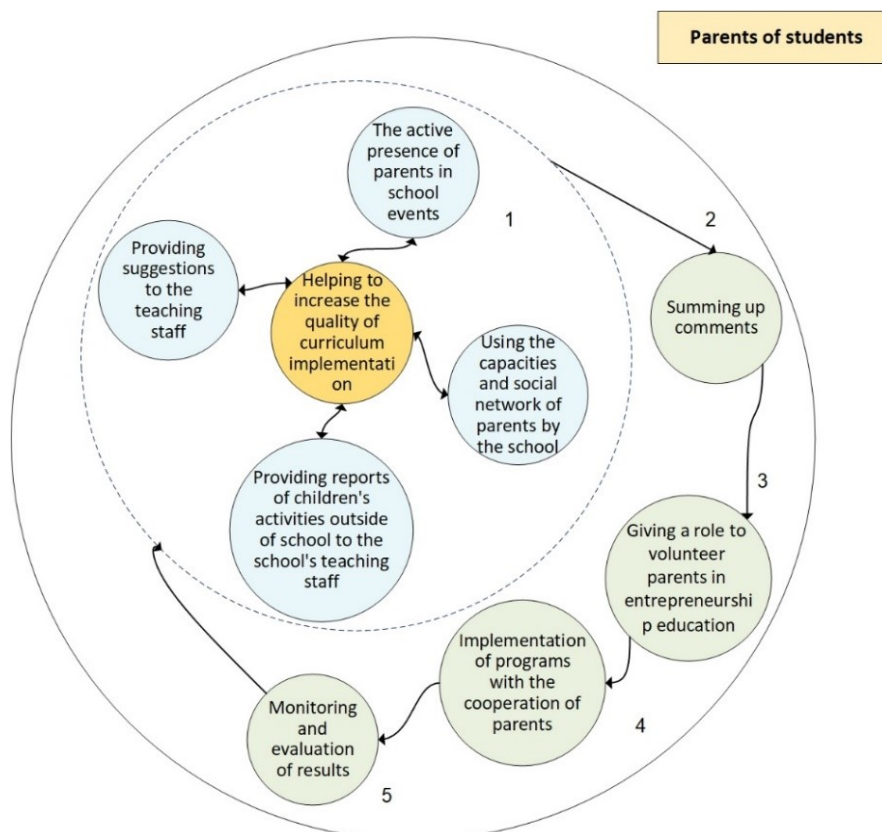
Figure 6. Conceptual model of students' parents' participation

4.3.6. The conceptual model of students

The conceptual model of students consists of four steps, depicted in Figure 7. In entrepreneurship education, students must play an active role in learning. First and foremost, it is essential to consider the needs of students, encompassing their knowledge, skills, and attitudes. It involves understanding students' specific requirements and learning objectives to

design and implement effective entrepreneurship education programs tailored to their needs. Also, students' opinions regarding how to execute programs should be considered as much as possible. Entrepreneurship mentors should design programs to give students a fair share of material and spiritual outputs. While designing entrepreneurship programs, doing practical activities of delegating responsibilities to students can positively affect their entrepreneurial competencies. Second, the designed programs will be executed. Having executed the programs, students must actively participate in program evaluation. Eventually, any necessary revision should be done based on feedback and learning.
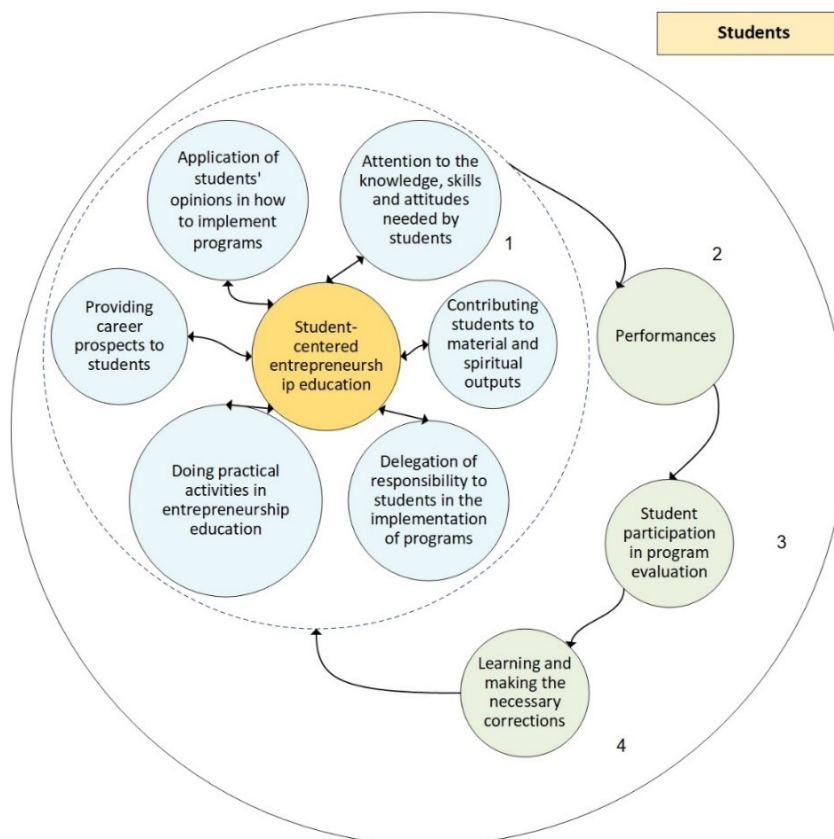
Figure 7. Students' conceptual model

4.4. Step 5: Hybrid model

The hybrid model for curriculum development at schools using the conceptual models is depicted in Figure 8. The model obtained from the conceptual models of the main actors includes five stages. First, problem definition should be done about the related topic. In order to achieve this, challenges and issues should be reviewed and prioritized by creating a think tank and holding various meetings with key actors. For this purpose, using experts' opinions and considering the existing limitations is essential. This step is done in the problem definition ecosystem.

Second, after the clear problem definition, the best approach and model to solve the problem should be selected. Due to achieving this goal, it is necessary to conduct case studies, review domestic and foreign research conducted on this issue, review the educational systems of leading countries, hold meetings with governing and legislative institutions, and receive the opinions and views of actors. This step is done in the model presentation ecosystem.

Third, control should be done before action. It means that before implementing the educational model, experts and professionals should check all aspects and effects of the intended model. The developed model should be implemented in a few selected schools or educational districts to accomplish this. It allows for a focused and controlled application of the model, enabling valuable data collection and feedback for further refinement and evaluation. Then the results should be checked to do any necessary revisions.

Fourth, the entrepreneurship education model should be implemented in the country's schools. Due to facilitate this goal, it is crucial to determine the implementation requirements of the model. It includes identifying the necessary resources. Moreover, there is a need to prepare the minds of schools to implement the entrepreneurship education model. Then, performance indicators of entrepreneurship education at schools should be defined. Moreover, finally, the entrepreneurship education model should be implemented to raise students' knowledge, skills, and attitudes. This stage is done in the implementation ecosystem.

Fifth, control should be done after action. It means controlling performance metrics of implementation and execution of entrepreneurship education should be done. Furthermore, reports should be received from the main actors about the implementation. At the end of this stage, learning will happen. Due to finishing this cycle, it can be continued until the optimal result is obtained. Upon completion, there are additional potential activities that can be pursued. These include: designing a mechanism to ensure the methodology aligns with the problem and investigating the universal procedures of entrepreneurship education at schools.
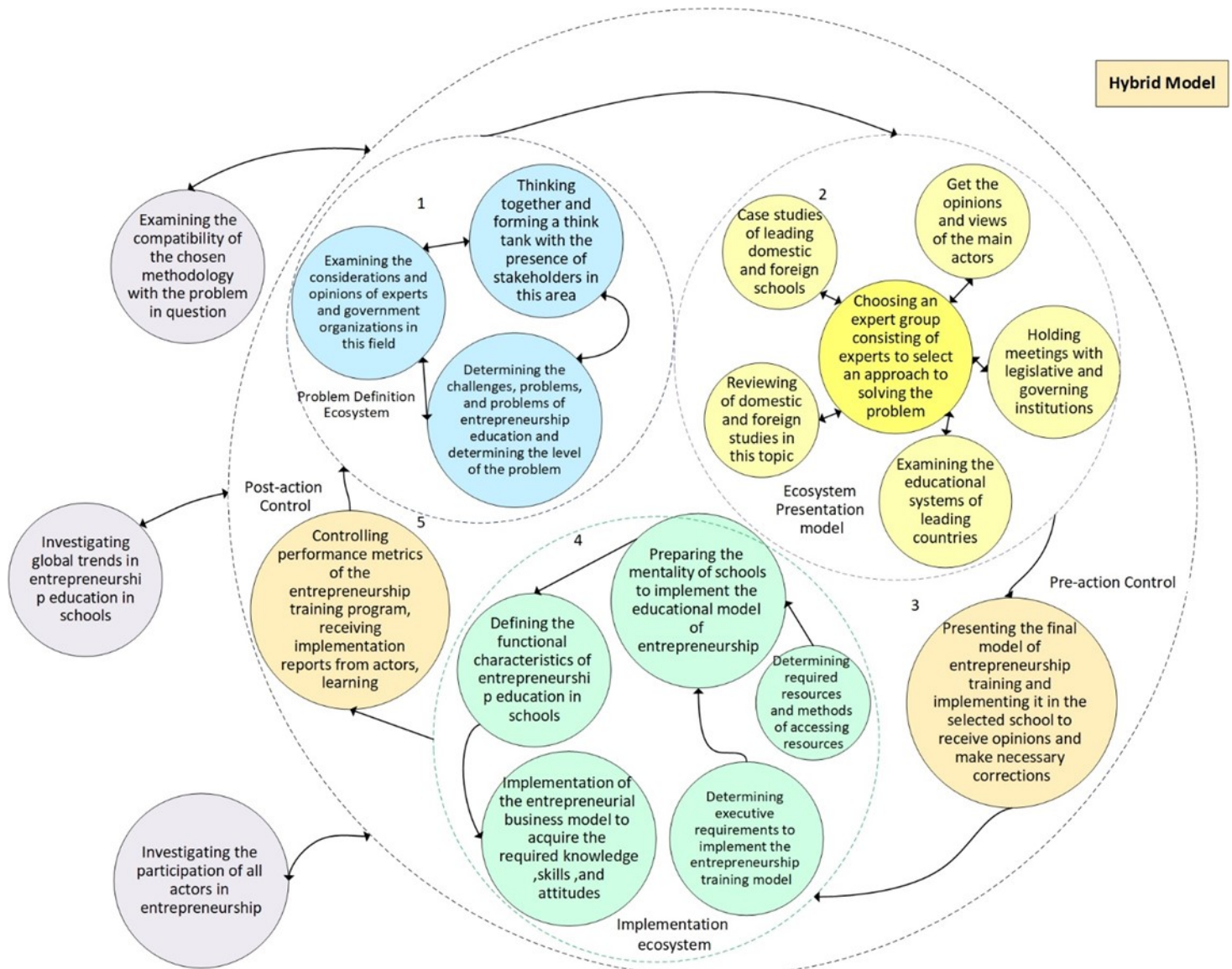
Figure 8. The final model resulting from the conceptual models of key actors in schools

4.5. Step 6 and 7: Changing and doing related actions

If the optimal curriculum model is to be practical, changes should be made in the current system. Some of these actions and related measures are unavailable and must be created. On the other hand, some others exist, but they are not carried out with appropriate mechanisms. So, it needs to be changed how it carries them out. Table 5 depicts all required actions and measures for each existing ecosystem for entrepreneurship education at schools. Table 8 shows the actions and measures necessary for each school's ecosystems.

Table 8. Necessary actions for optimal entrepreneurship education in schools

Is the situation favourable?	The current way of doing it.	Does it exist in the real world?	Action (conceived activities)	Ecosystem
no	according to circumstance	Rarely	Cooperating with ministries of leading countries, benefiting from their experiences	Education
no	It doesn't exist	no	Permitting companies to establish offices in schools	
no	If it happens	To some extent	Receive comments and suggestions from schools and teachers	
no	Usually a command	incompletely	Study and analysis of the latest research achievements	
To some extent	If it happens	It exists	Holding meetings with government organizations such as the Planning Organization to secure the necessary credit	
To some extent	according to circumstance	To some extent	Preparing the entrepreneurship support bill and holding meetings with the representatives of ICA to present proposals	
no	passive	rarely	Cooperation with professors and students of entrepreneurship in the form of a coach	schools
no	It doesn't exist	no	Consultation and cooperation with industry representatives	
no	It doesn't exist	no	Providing offices and other facilities to companies for permanent presence in schools, defining how students work with companies with the aim of benefiting each other.	
no	randomly	very limited	Using the capacities of students' parents in entrepreneurship education	
no	It doesn't exist	no	Cooperation with leading educational centers in entrepreneurship	
no	It doesn't exist	no	Taking advantage of the latest entrepreneurship education resources	
To some extent	Custom- made	yes	Use of global experiences in legislation	Islamic Consultative Assembly
To some extent	according to circumstance	yes	Asking experts	
no	It doesn't exist	no	Incentive plans for the presence of companies in schools	
no	It doesn't exist	no	Applying students' opinions on how to implement programs	Students
no	It doesn't exist	no	Contributing students to material and spiritual outputs	
no	It doesn't exist	no	Cooperation of students with established offices and companies in schools to strengthen entrepreneurial skills	
no	passive	To some extent	Providing career prospects to students	
no	according to circumstance	To some extent	Delegating responsibility to students in the implementation of programs	
To some extent	according to circumstance	It exists	Cooperation of students in the implementation of programs	

Is the situation favourable?	The current way of doing it.	Does it exist in the real world?	Action (conceived activities)	Ecosystem
no	Often in the form of theory - lack of coverage of practical and motivational aspects	To some extent	Equipping students with necessary knowledge, skills, and attitudes	
no	It doesn't exist	no	Student participation in program evaluation	
no	passive	To some extent	Provide feedback on students' activities at home and outside the school	Parents of students
no	It doesn't exist	no	Allowing and encouraging students to participate in company activities during non-class hours	
no	according to circumstance	rarely	Making suggestions to the management staff	
no	It doesn't exist	no	Implementation of programs with the cooperation of parents	
no	according to circumstance	yes	Sharing knowledge and experiences with students	Industries, startups, science and technology parks, and accelerators
no	It doesn't exist	no	Establishing a permanent office by industries in schools to use students' capacities, defining tasks for students to strengthen their entrepreneurial skills, and companies taking advantage of students' potential.	
no	according to circumstance	yes	Sharing available equipment and resources for entrepreneurship education	
no	it doesn't exist	no	Using students' ideas and sharing them in the project	

5. Discussion

Students' parents play a critical role in entrepreneurship education by providing economic and spiritual support. Related results are consistent with Lee-Gosselin and Grise (1990) on the effect of teaching the values of hard work, independence, and honesty on children's entrepreneurial characteristics. Also, research (Floris and Pillitu, 2019) acknowledges the role of parents in accompanying children in producing entrepreneurial products. The capacities of startup companies, science and technology parks, and accelerators can increase the efficiency of implementing entrepreneurship education programs. They can share their facilities, knowledge, and experience with students to improve their attitudes, knowledge, and skills as future entrepreneurs. The findings of this study are consistent with Kurowska-Pysz (2014) and (Huang et al., 2017) based on the positive impact of scientific entrepreneurship incubator program on students' managerial and entrepreneurship competencies and skills, the research of Hebles et al., (2019) based on the necessity of direct communication of students with business environments, the study of Winarno et al., (2019) and Athayde (2009) based on the working relationship of high school students with companies to increase students' entrepreneurial skills

and attitude, research of Chiloane-Tsoka (2016) based on the experience of working in the industry for students and the industry's support for students.

The Ministry of Education should apply policies that create students' motivation. The results are consistent with Morakinyo and Akinsola (2019), Floris and Pillitu (2019) and Pelletier (2007). Schools are responsible for implementing educational programs and evaluating the student's achievements. Schools can strengthen students' entrepreneurial skills by creating a suitable educational environment, using the latest methods of entrepreneurship education, allocating time, and hiring an entrepreneurship teacher. The results of this section are consistent with the findings of Evgrafova et al., (2019), Lubis et al., (2019), Steinke and Fitch (2007), Kenworthy-U'Ren et al., (2006), Sagar et al., (2012) and Sai et al., (2019). Students are responsible for the essential tasks as the main actors. They should strengthen and develop their knowledge and skills by actively participating in entrepreneurship training programs, performing assigned tasks, and increasing their capabilities to create a future business. The results of this section were consistent with Blenker et al., (2011), Roth et al. (2007), Maritz and Brown (2013), Izquierdo and Buelens (2011), Herger and Bodarky (2015), and Pruett (2012). As a significant actor, ICA can approve the required laws and allocate the budget. The results of this section were consistent with Floris and Pillitu (2019), European Commission (2013), Adekiya and Ibrahim (2016), Lindh and Thorgren (2016). Also, the approval of protective laws by the ICA and the identification of incentive plans by the Ministry of Education to establish startups in schools can significantly affect entrepreneurial education.

6. Conclusion

Nowadays, due to the inefficient educational system in schools, students do not communicate with necessary subjects in their lives. It causes students to be unable to use life opportunities (Hosseinikhah, 2002). By creating an efficient educational system, it is possible to train creative and innovative students as future entrepreneurs (Mehrabi, 2017). Therefore, this research aims is to develop an entrepreneurship education ecosystem to achieve this goal. In the current situation where emerging a problem, Soft System Methodology can be an appropriate tool for designing an entrepreneurship education ecosystem in Iranian schools.

The main steps are to design and implement an entrepreneurship education programs in Iranian schools, problem-definition ecosystem, model presentation, and implementation ecosystem. In problem-definition ecosystem, the consensus among actors and forming a think tank to identify entrepreneurship challenges are among the desired model's necessities. In a

model-presentation ecosystem, it is necessary to extract the material model by using case studies, studying previous research, interacting with educational systems of leading countries and their achievements, and holding meetings with relevant governing institutions. In an implementation ecosystem, the mindset of schools should be changed to implement entrepreneurship education model, and schools should find an attitude regarding implementing this issue. The resources should be determined.

The actions obtained to realize the desired model:

- Creating a think tank in the Ministry of Education with experts and actors.
- Approval of protective laws by ICA and definition of incentive plans by the Ministry of Education (Morakinyo and Akinsola., 2019) to establish start-ups in schools and to involve students, using students' ideas (Huang et al., 2017).
- Applying students' opinions in implementing programs, cooperation in implementing programs, and contributing to students'material and spiritual outputs (Herger and Bodarky, 2015).
- Cooperation of schools with entrepreneurship professors and students in the form of mentors, using the capacities of students' parents in entrepreneurship education by schools. (Lee-Gosselin and Grise, 1990)
- Using world experiences in legislation by ICA, cooperating with ministries of leading countries, preparing a bill to support entrepreneurship, and holding meetings with representatives of ICA to present proposals (Floris and Pillitu, 2019).
- Implementing programs with the cooperation of parents and providing feedback on students' activities at home and outside the school by parents (Floris and Pillitu, 2019).

The present research has significant educational, theoretical, and policy outcomes for entrepreneurship education in Iran. In this research, the components of the entrepreneurship education ecosystem in Iranian schools and the required approaches to improve the activities of this ecosystem were indicated. Also, the way of interaction between the components of this ecosystem and the needed actions for each part are among the contributions of this research.

7. Limitations and suggestions

The unfamiliarity of the interviewees with soft systems was a limitation of this study. It could affect the incompleteness of the rich picture of interviews.

Iran's current entrepreneurship curriculum and education needs to improve, and requiring a general reform in its structure. The following is a list of practical recommendations: Establishing a permanent office by industries in schools to use students' capacities, defining tasks for students to strengthen their entrepreneurial skills, taking advantage of students' potential, Sharing available equipment and resources for entrepreneurship education by companies, using students' ideas and sharing them in the project, creating a think tank in the Ministry of Education using the experts, authorities, and the actors of this field, designing the entrepreneurship education model with the pivotal role of the Ministry of Education and piloting

it in some regions. The following is a list of useful recommendations for future research in soft systems methodology: Determining the interactions among actors and the critical activities for each of them in the problem-definition ecosystem, determining the interactions among actors and the critical activities for each of them in the model-presentation ecosystem, determining the interactions among actors and the critical activities for each of them in the implementation ecosystem, using other experienced expert actors in this field to reinforce the optimal model, interviewing more experts with different views to increase the richness of rich picture.

Disclosure statement
No potential conflict of interest was reported by the author(s).

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Developing a 3-Dimensional Model of Importance-Performance-Cost Analysis for Prioritizing the Quality Attributes of Mobile Phone Operator Services

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A B S T R A C T

In today's competitive world, discovering the needs and desires of customers and fulfilling them before competitors is the condition for success for companies. Therefore, organizations and business enterprises try to achieve a privileged position compared to other competitors by achieving unique advantages. This study aims to develop the importance-performance analysis by adding the cost dimension. Then, measure and compare the quality of the services of two communication networks, Hamrahe Aval, and Irancell, using the developed approach of Importance-Performance-Cost Analysis (3-D IPCA) and proposing the optimal strategy to improve service quality. For this purpose, were identified the relevant attributes by studying the literature, then provided to the experts in the form of a questionnaire for final confirmation. Finally, 20 attributes were identified in determining the quality of mobile phone operators' services. The questionnaire was distributed among 400 Ferdowsi University of Mashhad students as a convenience sample. Then it was analyzed using three-dimensional IPCA analysis.

The results showed that among the users of the Hamrahe Aval network, the quality of providing services and customer support, and among the users of the Irancell network, network coverage and ease of use of services have the highest and lowest priorities for improvement, respectively. Also, Irancell's performance has been better considering the cost aspect. The comparison of IPA and IPCA shows that IPCA considering the cost as a third dimension can obtain more accurate analyzes of customers' opinions. Moreover, managers can make more rational decisions with this tool.

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1. Introduction

The telecommunications industry is becoming one of the most important industries in the world and has affected the global economy. Increasingly, with the advancement of technology in this industry, the transfer of photos, audio, images, and data is done with high speed and quality. Following these developments, the environment of the companies in this industry becomes turbulent. Furthermore, the marketers of this industry seek to create a sustainable competitive advantage through innovation and customer satisfaction (Haghighi et al., 2013) to the extent that these mobile phone operators have focused their marketing strategies on attracting new customers and customers from other operators.

Researchers in the mobile phone service industry have proven the quality of mobile phone service providers on customer satisfaction and loyalty. Therefore, mobile phone operators should not only provide services according to the needs and expectations of customers but also continuously strive to improve the quality of their services to achieve a competitive advantage. Also, at the same time as attracting new customers, increase the loyalty of their existing customers. Therefore, mobile phone operators must identify and prioritize service attributes to manage communication with customers effectively.

The literature study shows that some studies such as Wen and Hilm (2011), Rahhal (2015), Loke et al. (2011), Hosseini et al. (2013), Dharmadasa and Gunawardan (2017), and Palladan and Ahmad (2019) have used Seroquel and Seroperf While using general quality-service models such as Seroquel will not result in practical and effective results and suggestions for managers.

Some studies as Faria et al. (2015), used the AHP method, and Kargar (2016) used Dimtel and ANP techniques to prioritize service attributes. Nevertheless, using these methods does not determine the weakness and strength of the relevant organization in each of the priorities. At the same time, function-importance is a low-cost, easy-to-understand method for organizing information about the attributes of a product or service. It presents attractive, intuitive strategies for the industry. It determines their priority for implementation so that they can ultimately provide more customer satisfaction and is one of the tools for managing relationships with customers. Also, IPA simultaneously identifies the most important attributes affecting customer satisfaction as well as the low-performance attributes of the organization that must be quickly improved and thus recommends strategies to the management to provide better customer service. Therefore, in this research, performance-importance-cost analysis is used to prioritize the services of mobile phone operators.

On the other hand, Petrick (2004) states the need for more customer satisfaction measurement if it needs to be supported by in-depth learning about the perceived value of the customer and related issues that form the basis of their evaluations. It may need to guide managers enough to hear the customers' Voice of Customer and how to respond to them. The perceived performance of a product or service equals the perceived value, or perceived level of perceived quality, concerning the price or prices paid (Johnson et al., 2001).

When a consumer buys a product, he exchanges one value with another. The value he loses is the price he pays for the goods, and the value he gains is the benefits of owning the goods (Shabanipour et al., 2016). Customer perception of price fairness directly affects customer satisfaction. However, less attention has been paid to the price acceptance factor than other customer satisfaction attributes (Martin-Consuegra et al., 2007). Price is an important factor in the purchase process and after purchase, and the central role of price in services can be understood considering the complex pricing structure. The studies of Hossain and Suchy (2013), Wen and Hilm (2011), Munnukka (2006), Hassan et al. (2013), Chakraborty and Sengupta (2014), Liang et al. (2013) and, Chee and Husin (2020) have stated cost as an effective factor in customer satisfaction. However, the above studies are statistical and have investigated and confirmed the effect of price on customer satisfaction.

As mentioned earlier, the importance and performance analysis approach is a low-cost and attractive method for prioritizing mobile operator services. Furthermore, several studies, including Hosseini et al. (2012) and Pezeshki et al. (2009), have used this approach to analyze service quality. Nevertheless, this approach does not cover the cost dimension, and its analysis will not be based on cost. Quality and price are two important and influential factors in a buyer's decision to cooperate or continue with a supplier. Therefore, prioritizing the features of a product based on performance and importance without considering its cost and increasing the price of the product will not be the correct strategy. Business managers need to know how much a customer is eager to pay to obtain a high-performance feature. Therefore, due to the importance of the cost factor, there is a gap in the importance and performance approach, and none of the research background studies need to pay attention to the cost dimension in the importance-performance analysis. So in the present study, the mentioned approach has been developed, and the third dimension of cost has been added to this approach. Moreover, the prioritization of mobile phone operator service features based on performance and importance concerning cost is also analyzed.

2. Theoretical foundations and research background

2.1. Quality of service

According to Parasuraman et al., (1998) service quality is defined as 'the consumer's judgment about an entity's overall excellence or superiority' of the service; the authors use the concept of 'perceived service quality', which differs from objective quality (Parasuraman et al., 1988). Service quality measures how an organization delivers its services compared to the expectations of its customers. Customers purchase services as a response to specific needs. They either consciously or unconsciously have certain standards and expectations for how a company's delivery of services fulfills those needs. A company with high service quality offers services that match or exceed its customers' expectations (Indeed, 2022).

2.2. Service cost

Price plays an important role in buying and after buying. The results of the qualitative research showed that more than half of the customers of one of the services started buying from the competitors due to a weak perception of the price (compared to competitors) (Keaveney, 1995). Varki and Colgate (2001) reached similar results with research in the banking industry, significantly since price perception directly affects customer satisfaction. Based on the research of Matzler et al. (2006), the fairness and unfairness of the price is a psychological factor that has an important effect on the customer's reaction to the price. Customers do not want to pay a price that they think is unfair.

Value perception sets the price ceiling, while cost sets the price floor for what a company can charge for its goods or services (Kotler and Armstrong, 2014). In setting prices, the primary objective of most companies is to recover input costs and then make a profit. As a result, customers have to pay the set price in recompense for the total benefits they receive from the goods or services bought, which also allows the seller to recover input costs and make a profit (Porter and Kramer, 2011). Customers must experience good quality in the service received to perceive it as good value for money. The perceived value has been conceptualized as the difference between total benefits and total costs of service (Kotler et al., 2012). Total benefit has also been defined by Lee and Cunningham (2001) to include economic benefit (the lower price paid compared to alternatives), functional benefit (the good service performance that satisfies the desired need), and psychological benefit (the good feeling of satisfaction after service experience).

2.3. Background research

Hosseini et al. (2013), in their research, using the importance-performance analysis of service features based on customer segmentation with a data mining approach, classified mobile phone

subscribers in Yazd province into three segments. Sheikhzadeh et al. (2013) compared the satisfaction of customers from the value-added services of two companies, Moharb and Irancell. They concluded that although value-added services create customer satisfaction, they cannot determine the operator's decision.

Taghizadeh and Meskarian (2013) investigated female customers' satisfaction levels with the mobile phone services of two companies, Irancell and Hamrahe Aval, in Urmia City. The results of their study showed that the Hamrahe Aval company is ahead of Irancell in the field of quality service, after-sales service, and proper antenna service in the city. Faria et al. (2015) measured and investigated customer satisfaction with mobile phone services using the fuzzy AHP approach. They examined customer satisfaction indicators in four main groups: price, perceived service quality, customer experience, and service and product development and creativity. Hosseinzadeh and Hatami Ghoshchi (2014) evaluated and compared customer satisfaction with the quality of telecommunication services provided by Irancell in Urmia and concluded that customer satisfaction with service quality is the same.

Wang and Lu (2002) researched service quality, customer satisfaction, and behavioral tendencies in the Chinese telecommunications industry using the SERVQUAL model. They concluded that all the attributes affecting service quality, except for the responsibility factor, play an important role in customers' perception of service quality in the mobile phone market. Ojo (2010) investigated the relationship between service quality and customer satisfaction in the telecommunications industry, focusing on the Nigerian mobile communication network. Wen and Hilmi (2011) used five dimensions of the SERVQUAL model and four other dimensions, i.e., perceived quality of the network, pricing structure, convenience, and value-added services, to measure service quality in the mobile telecommunications industry in Malaysia were used. This study shows that dimensions of service quality such as reliability, empathy, customer-perceived network quality, pricing structure, and value-added services have a positive relationship with customer satisfaction. Loke et al. (2011) investigated the effect of reliability, responsiveness, assurance, empathy, and tangible aspects on customer satisfaction in a telecommunications service provider using the Cerval model.

Using structural equations, Nimako (2012) investigated the impact of service quality on customer satisfaction and customer behavioral intention in the mobile telecommunications industry. Hossain and Suchy (2013) investigated the effect of customer satisfaction on customer loyalty in Bangladesh. The results of their study show that five attributes: communication, price structure, value-added services, convenience, and customer service/care have a positive

relationship with customer loyalty. Hassan et al. (2013) investigated the effect of service fairness, service quality, and price fairness perception on subjective customer satisfaction and customer loyalty in the mobile telecommunications sector of Pakistan. The results of their study show that service fairness, service quality, and perception of price fairness are valid and reliable for measuring customer satisfaction and loyalty. Hosseini et al. (2013) conducted a multidimensional measurement model (MS-Qual) to measure the quality of mobile telecommunication services. The findings of this study showed that customers perceive their service quality based on their evaluation of seven main dimensions, including network quality, value-added services, pricing plans, staff competence, billing system, customer service, and service convenience. Liang et al. (2013) surveyed 400 customers to investigate the importance of service quality from various aspects and customer switching behavior in China's mobile service sector. Chakraborty and Sengupta (2014) developed a customer satisfaction model for mobile phone network providers in Kolkata. Their findings show that general requirements (combination of product quality and perceived value), flexibility, and price determine customer satisfaction. Rahhal (2015) analyzed the effects of service quality dimensions on customer satisfaction in Syrian mobile phone companies. The findings of this study show the direct and significant effect of service quality on customer satisfaction from three dimensions (network quality, responsiveness, reliability), and other dimensions did not affect customer satisfaction. Dharmadasa and Gunawardane (2017) investigated the effect of service quality on customer satisfaction in the mobile communications industry in Sri Lanka to increase customer satisfaction. They used the Serkerval model. Their study shows that the main dimensions of service quality affecting customer satisfaction are empathy, tangible, and reliability. Other dimensions of responsiveness, reliability, and technical quality do not affect customer satisfaction. Mpwanya and Letsoalo (2019) used partial least squares structural equation modeling to examine the relationships between Service Quality (SQ), Customer Satisfaction (CS), and Behavioral Intentions (BI) in South Africa. The results of this study show that tangible items (TAN), customer relationship (CR), real network quality (RNQ), picture quality (IMQ), as well as CS, are significantly related in the South African mobile telecommunications industry. Palladan and Ahmad (2019) investigated the moderating effect of customer satisfaction on the relationships between dimensions of service quality and customer loyalty in the mobile telecommunications industry in Nigeria. The results of their study show that confidence, empathy, reliability, and tangibility have a positive relationship with customer loyalty. Chee (2019) has presented a conceptual framework that links the relationship between

service quality, customer satisfaction, customer loyalty, and customer retention in measuring the quality of services provided by telecommunication phones.

Hapsari et al. (2020) conducted a study to verify the dimensions of customer interaction and investigate the effect of service fairness, customer trust, and customer interaction on customer loyalty. The results of their study show that customer trust and interaction have a direct effect on customer loyalty. Chee and Husin (2020) investigated the service quality, satisfaction, and loyalty to care retention in the telecommunications industry in Malaysia. Their study results show a significant relationship between customer satisfaction and service quality measured network utilization, service delivery, and price evaluation.

Karimi and Boley (2022) conducted a study to identify the service quality perceptions tourists and residents have of the domestically and internationally significant cultural heritage tourism attraction of Shandiz, located within the Khorasan Razavi province of Northern Iran. To address this aim, they use traditional and contemporary approaches to IPA, such as gap analysis, Impact Range Performance Analysis (IRPA), and Impact Asymmetry Analysis (IAA).

The literature review results show that different dimensions are considered for service quality. In this study, previous research was comprehensively examined to identify the dimensions and indicators of service quality in mobile phone operators, and the common items, according to Table 1, were considered as dimensions of service quality. Also, a review of the research background shows that most of the research, such as Wang and Lu (2002), Nazari et al. (2014), Dharmadasa and Gunawardan (2017), Mpwanya and Letsoalo (2019), Palladan and Ahmad (2019), and Chee and Husin (2020) have used the SERVQUAL model and statistical methods in examining service quality and customer satisfaction.

While according to Song and Shepperd (2011), statistical methods could be more efficient in the face of more information. Also, in statistical methods such as multiple regression or structural equations that require assumptions such as normal distribution, the data under investigation, and the existence, there is a linear relationship between independent and dependent variables and low collinearity between independent variables. At the same time, in most studies, it is impossible to be sure of the existence of all these assumptions (Deng et al., 2008). Also, one of the shortcomings of the SERVQUAL model is not paying attention to the importance of each index and the existence of expectations in the evaluation (Noorossana et al., 2018). To solve this problem and rank the indicators IPA technique can be used. When increasing service quality and customer satisfaction, importance/performance analysis can be valuable for prioritizing service indicators (Deng and Pei, 2009). The IPA technique is a type

of multi-criteria decision-making. Multi-criteria decision-making techniques are more suitable tools (Fazli et al., 2011; Shafii et al., 2016). In studies such as Pezeshki et al. (2009) and Hosseini et al. (2012) used the usual IPA technique, the indicators were examined in only two dimensions: performance and importance. At the same time, cost is also an effective factor in customer satisfaction. Therefore, this research developed the usual IPA into a three-dimensional IPCA.

Table 9. Extraction of attributes affecting service quality

NO	Attribute Name	References
1	Conversation quality	Taghizadeh and Meskarian (2013), Chakraborty and Sengupta (2014), Liang et al., (2013), Gautam (2011), Gunjan et al., (2011), Santouridis and Trivellas (2010), Rahhal (2015), Nimako (2012), Mpwanya and Letsoalo (2019), Hossain and Suchy (2013), Hosseini et al., (2013), Mathiraj et al., (2019)
2	Network coverage	Taghizadeh and Meskarian (2013), Chakraborty and Sengupta (2014), Rahhal (2015), Palladan and Ahmad (2019), Wen and Hilmi (2011), Nimako (2012), Mpwanya and Letsoalo (2019), Hossain and Suchy (2013), Dharmadasa and Gunawardane (2017)
3	Diversity and innovation	Taghizadeh and Meskarian (2013), Gunjan et al., (2011), Palladan and Ahmad (2019), Hassan et al., (2013), Chee and Husin (2020), Hossain and Suchy (2013), Mathiraj et al., (2019), Ojo (2010)
4	Quality in service delivery	Hosseini et al., (2013), Nimako (2012)
5	Service Convenience	Rahhal (2015), Nimako (2012), Liang et al., (2013), Wen and Hilmi (2011), Palladan and Ahmad (2019)
6	Sufficient number of agencies	Rahhal (2015), Hossain and Suchy (2013), Nimako (2012), Mpwanya and Letsoalo (2019), Liang et al., (2013)
7	billing accuracy	Dharmadasa and Gunawardane (2017), Santouridis and Trivellas (2010), Chee and Husin (2020), Chakraborty and Sengupta (2014)
8	cost clarification	Hossain and Suchy (2013), Hassan et al., (2013), Santouridis and Trivellas (2010), Chee and Husin (2020), Chakraborty and Sengupta (2014), Mathiraj et al., (2019)
9	Fix possible billing problems	Santouridis and Trivellas (2010), Chee and Husin (2020), Hosseini et al., (2013)
10	Competence and skill in responding	Rahhal (2015), Wen and Hilmi (2011), Palladan and Ahmad (2019), Loke et al., (2011), Nimako (2012), Ojo (2010), Hassan et al., (2013), Dharmadasa and Gunawardane (2017), Mpwanya and Letsoalo (2019)
11	Courtesy and respect	Rahhal (2015), Ojo (2010), Hassan et al., (2013), Dharmadasa and Gunawardane (2017), Loke et al., (2011), Nimako (2012)
12	Efforts to solve audience problems	Rahhal (2015), Ojo (2010), Loke et al., (2011), Nimako (2012), Hassan et al., (2013), Dharmadasa and Gunawardane (2017)
13	Tariff diversity	Hossain and Suchy (2013), Gunjan et al., (2011), Chakraborty and Sengupta (2014)
14	Easy to choose and change tariffs	Gunjan et al., (2011), Hossain and Suchy (2013), Hosseini et al., (2013)
15	Provide sufficient information related to the tariff	Ojo (2010), Loke et al., (2011), Chakraborty and Sengupta (2014), Gunjan et al., (2011), Hossain and Suchy (2013)
16	Customer support	Rahhal (2015), Nimako (2012), Santouridis and Trivellas (2010), Gautam (2011), Gunjan et al., (2011), Loke et al., (2011), Dharmadasa and Gunawardane (2017)
17	Convenience in transferring problems	Ojo (2010), Gautam (2011), Gunjan et al., (2011), Loke et al., (2011), Santouridis and Trivellas (2010), Hossain and Suchy (2013)
18	Handling complaints	Rahhal (2015), Loke et al., (2011), Gautam (2011), Gunjan et al., (2011), Hossain and Suchy (2013), Santouridis and Trivellas (2010)
19	Internet network quality	Nimako (2012), Mpwanya and Letsoalo (2019), Chakraborty and Sengupta (2014), Dharmadasa and Gunawardane (2017), Chee and Husin (2020)
20	Internet network coverage	Nimako (2012), Mpwanya and Letsoalo (2019), Chakraborty and Sengupta (2014), Chee and Husin (2020)

3. Research methodology

Research is an analytical survey in terms of practical purpose and according to data collection. After studying the background of the research, twenty attributes in determining service quality have been identified and approved by experts in the second stage (Table 1). The method of data collection in the developed approach of IPCA is a questionnaire. Ten experts checked and confirmed the validity of the questionnaire. The experts in this research are active managers in Hamrahe Aval service networks and Irancell. A five-point Likert scale is used in this questionnaire. The data analysis was done based on the IPCA and IPA analysis approach. The statistical population included all students at Ferdowsi University of Mashhad in the academic year of 2019-2020. The questionnaire was distributed among 400 students of the Ferdowsi University of Mashhad in the form of an available sample.

3.1. Developed IPCA methodology

Importance-performance analysis (IPA) has been widely utilized in brand optimization, service quality, and customer satisfaction applications since its initial introduction by Martilla and James (1997). IPA is a popular tool because it is easy to operate, and its results are easily interpretable (Feng et al., 2014). The original IPA model relies on data typically collected via survey. After calculating the performance and importance of various attributes, the means of performance and importance can be plotted onto the four quadrants of a two-dimensional (2D) matrix grid. On this matrix grid, the performance of a given attribute is plotted on the X-axis, and the importance of the attribute is plotted on the Y-axis; in this research, the third axis of Z, which is the cost, was added to it.

This original IPA model (quadrant model) has been applied in many previous studies, including Zhang and Chow (2004), Hudson et al. (2004), Prajogo and McDermott (2011), Sorensson and Friedrichs (2013), Pan (2015), Hanssen and Mathisen (2018), and Birendra et al. (2018). In addition to this original quadrant model, the diagonal line model has also been widely used, including in studies by Slack (1994), Nale et al. (2000), Levenburg and Magal (2005), Sirdifield et al. (2016), Sulaiman Al Jahwari et al. (2016), and Boley et al., (2017). But for the first time in this research, the third dimension is added cost.

3.1.1. Steps of performance-importance-cost analysis

The new Performance-Importance-Cost Analysis is calculated according to the following steps:

The first step: The quality attributes that play a role in service quality have been identified and extracted. This work has been done by studying the subject literature and asking for opinions from experts and customers.

The second step: The degree of importance of service quality attributes and the degree of performance and cost of that quality attribute are determined. b_{jp} ، c_{jp} ، h_{jp} (j=1,2,…,m ، p=1,2,…,n) respectively, represent the value of importance, performance value, and cost value, which are for attribute j and by the decision-maker or customer p M is determined. These values can be determined using a Likert scale. A five-level Likert scale was used in this research.

The third step: The geometric mean, is used, and the opinions of all decision-makers or customers are integrated. In this way, b_j is the final value of importance, c_j is the final value of the performance, and h_j is the final value of cost j^{th} attribute of service quality, which results from the collective opinion of p customers or experts. Equation 1 shows this step.

$$c_j = \left(\prod_{i=1}^{n} c_{jp}\right)^{1/n} \ , \quad b_j = \left(\prod_{i=1}^{n} b_{jp}\right)^{1/n} \ , \quad h_j = \left(\prod_{i=1}^{n} h_{jp}\right)^{1/n} \tag{1}$$

Thus, each jth quality attribute has an important degree, a performance degree, and a cost degree.

The fourth step: The threshold value is calculated. The threshold value is used to determine the cells of the IPCA matrix. The arithmetic average is used to determine the threshold value. μ_b, μ_c, and μ_h represent the importance threshold values and the performance threshold values.

$$\mu_b = \frac{\sum_{j=1}^{m} b_j}{m} \ , \mu_c = \frac{\sum_{j=1}^{m} c_j}{m} \ , \mu_h = \frac{\sum_{j=1}^{m} h_j}{m} \tag{2}$$

Where m is the number of quality attributes to measure service quality.

The fifth step: The relative position of each of the quality attributes of the service is determined on the IPCA matrix.

The sixth step: Discovering the voice of the customer helps to gain the weight of the customer's wishes. The gap between the importance value and performance of the jth attribute multiplied by its importance value can show the weight of the jth quality attribute. Equation 3 shows that the weight of the jth attribute is denoted by ow_j. Of course, in the developed approach of this research, it will be changed according to Equation 4 due to the addition of cost.

$$OW_j = \left|(b_j - c_j) \times b_j\right| \qquad (3)$$

$$OW_j = \frac{\left|(b_j - c_j) \times b_j\right|}{h_j} \qquad (4)$$

For more ease of analysis, it is normalized as follows.

$$sw_j = \frac{ow_j}{\sum_{j=1}^{m} ow_j}, \quad 0 \le sw_j \le 1, \quad \sum_{j=1}^{m} sw_j = 1 \qquad (5)$$

The attributes with more sw_j should be prioritized for improvement (Azar et al., 2016). Therefore, in the IPCA approach, in the same way, attributes with more sw are given higher priority.

4. Results

This research aims to measure and compare the quality of services of two communication networks, Hamrahe Aval and Irancell, using the developed approach of importance-performance-cost analysis and proposing a suitable strategy to improve service quality. The sample includes two groups of users of the Hamrahe Aval network and Irancell. Table 2 shows the results obtained from the IPCA and IPA.

Table 10. The results of attribute ranking from the perspective of Irancell users

	Attribute name	Importance	Performance	Cost	IPCA		IPA	
					Normalized weight	Rank	Normalized weight	Rank
1	Conversation quality	4.197	3.340	4.046	0.0907	5	0.0550	8
2	Network coverage	5.000	3.474	3.395	0.1613	1	0.1165	3
3	Diversity and innovation	4.257	3.330	2.097	0.0515	7	0.0602	7
4	Service Convenience	5.000	5.000	3.426	0.0000	20	0.0000	20
5	Quality in service delivery	5.000	3.330	3.008	0.1564	2	0.1274	2
6	Sufficient number of agencies	2.397	3.707	2.269	0.0444	9	0.0479	10
7	Billing accuracy	2.397	4.318	2.276	0.0652	6	0.0703	5
8	Cost clarification	3.584	3.494	2.982	0.0060	18	0.0049	19
9	Fix possible billing problems	4.186	2.671	3.000	0.1184	3	0.0968	4
10	Competence and skill in responding	2.419	4.318	1.431	0.0409	10	0.0701	6
11	Courtesy and respect	3.524	3.707	1.322	0.0053	19	0.0099	16
12	Efforts to solve audience problems	4.197	3.707	1.891	0.0242	12	0.0314	12
13	Tariff diversity	4.197	4.504	1.891	0.0152	13	0.0197	13
14	Easy to choose and change tariffs	4.197	4.504	1.690	0.0135	14	0.0197	13

	Attribute name	Importance	Performance	Cost	IPCA		IPA	
					Normalized weight	Rank	Normalized weight	Rank
15	Provide sufficient information related to the tariff	2.460	2.188	1.690	0.0070	16	0.0102	15
16	Customer support	3.524	4.318	1.891	0.0329	11	0.0427	11
17	Convenience in transferring problems	2.881	2.704	2.982	0.0095	15	0.0078	17
18	Handling complaints	2.881	2.704	1.903	0.0060	17	0.0078	17
19	Internet network quality	5.000	4.293	2.255	0.0496	8	0.0539	9
20	Internet network coverage	5.000	3.062	1.690	0.1019	4	0.1479	1
	The value of the province	3.815	3.634	2.357				

Based on the results in Table 2, "Network coverage", "Quality in service delivery", "Service Convenience", "Internet network quality ", and "Internet network coverage" are the most important attributes among Irancell network users. The attribute of Service Convenience has the highest performance. The "Conversation quality" costs the most. The "network coverage" attribute is the most important. In contrast, according to Irancell users, this attribute has a relatively high cost and low performance, which according to Table 3, is in the " Concentrate on cost and performance" quadrant. Finally, "Network coverage" and "Service convenience" have the highest and lowest weights in the IPCA approach. However, in the IPA approach, "Network coverage" ranks third in prioritization.
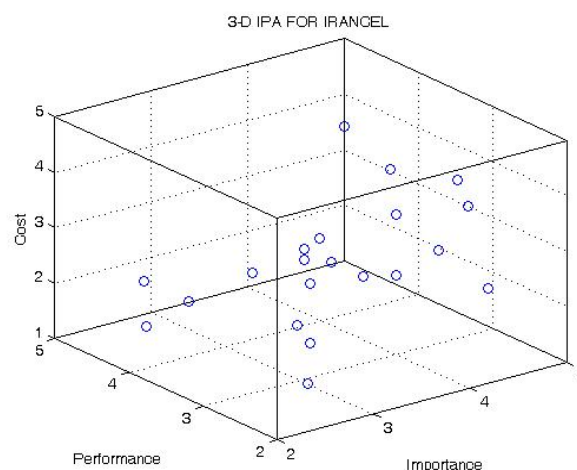
Figure 9. Three-dimensional diagram of Irancell network service quality attribute ranking

It can also be seen in Figure 1 that the cost of most attributes is relatively low. As a result, the threshold value is also low, so it can be concluded that Irancell has successfully implemented cost-reduction policies.

Table 11. The results of ranking the indicators from the perspective of Hamrahe Aval users

	Attribute name (attribute)	Importance	Performance	Cost	IPCA		IPA	
					Normalized weight	Rank	Normalized weight	Rank
1	Conversation quality	4.203	2.662	3.569	0.0552	7	0.0637	5
2	Network coverage	4.949	2.634	3.569	0.0976	2	0.1128	2
3	Diversity and innovation	4.246	3.055	1.728	0.0209	15	0.0498	9
4	Service Convenience	4.949	3.000	4.203	0.0968	3	0.0950	3
5	Quality in service delivery	5.000	1.790	4.203	0.1610	1	0.1580	1
6	Sufficient number of agencies	2.405	3.000	5.000	0.0171	18	0.0141	18
7	Billing accuracy	2.484	3.933	5.000	0.0430	10	0.0354	12
8	Cost clarification	3.551	3.000	5.000	0.0233	14	0.0193	15
9	Fix possible billing problems	4.203	3.000	4.203	0.0507	9	0.0498	10
10	Competence and skill in responding	2.458	3.933	3.000	0.0260	13	0.0357	11
11	Courtesy and respect	3.533	3.000	4.203	0.0189	17	0.0185	16
12	Efforts to solve audience problems	4.157	2.347	5.000	0.0898	4	0.0741	4
13	Tariff diversity	4.224	3.814	5.000	0.0207	16	0.0171	17
14	Easy to choose and change tariffs	4.181	5.000	3.569	0.0292	12	0.0337	13
15	Provide sufficient information related to the tariff	2.471	3.000	5.000	0.0156	19	0.0129	19
16	Customer support	3.569	3.814	5.000	0.0104	20	0.0086	20
17	Convenience in transferring problems	2.940	5.000	3.569	0.0516	8	0.0596	6
18	Handling complaints	2.940	3.814	5.000	0.0307	11	0.0253	14
19	Internet network quality	5.000	3.814	5.000	0.0708	5	0.0584	7
20	Internet network coverage	5.000	3.814	5.000	0.0708	5	0.0584	7
	The value of the province	3.823	3.371	4.291				

Based on the results in Table 3, the "Internet network coverage", "Internet network quality", and the "Quality in service delivery" among the users of the Hamrahe Aval network have the highest importance. The highest performance was related to "Easy to choose and change tariffs" and "Convenience in transferring problems". Finally, "Quality in service delivery" and "Customer support" have been given the highest and lowest priority, respectively. As shown in Figure 3, the Hamrahe Aval service network has high costs in several indicators and should take steps to reduce them.
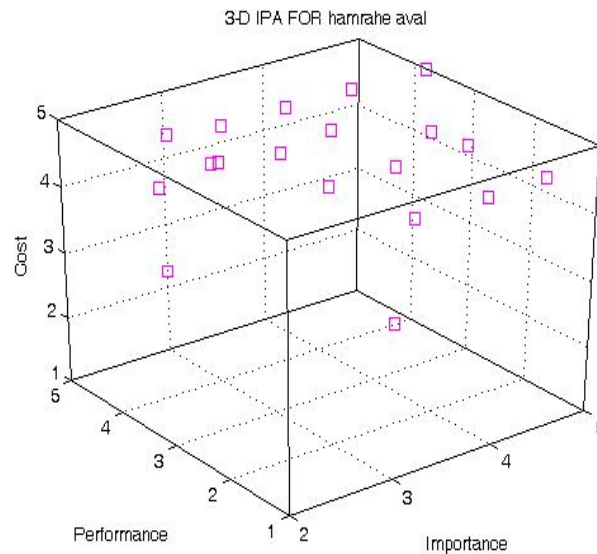
Figure 10. Three-dimensional diagram of the ranking of service quality indicators of the Hamrahe Aval network

According to the results obtained in Tables 2 and 3, it can be seen that among Hamrahe Aval users, the "Quality in service delivery" and "Customer support", and among Irancell users, "Network coverage" and "Service convenience" are respectively the highest and have been the least priority. According to Irancell's cost limit value of 2.35 compared to the cost limit value of 4.29 of the Hamrahe Aval and as can be seen from Figure 3, most of the attributes in the Hamrahe Aval phone have a high cost, so it is suggested to the mobile phone managers to pay special attention to reducing costs.

Table 12. importance-performance-cost matrix

The name of the quarter	Dimension status	Irancell	Hamrahe Aval
		Attribute number	Attribute number
Low priority	Low importance, low performance, low cost	15-8	----------
Possible overkill	Low importance, high performance, low cost	6-7-10-11-16	10-17
The situation is dire	Low importance, low performance, high cost	8-17	6-8-11-15-18
Useless	Low importance, high performance, high cost	----------	7-16
Concentrate on performance	High importance, low performance, low cost	3-20	1-2-3-4-5
Keep up the good work	High importance, high performance, low cost	12-13-14-19	14
Concentrate on cost and performance	High importance, low performance, high cost	1-2-5-9	9-12
Concentrate on cost	High importance, high performance, high cost	4	13-19-20

According to the results of Table 4, in terms of attributes of "Efforts to solve audience problems", "Tariff diversity", "Easy to choose and change tariffs", and "Internet network quality", Irancell is located in the quadrant of "Keep up the good work". Nevertheless, the

Hamarhe Aval company is in this quadrant only in terms of "Easy to choose and change tariffs". As can be seen in Table 4, Irancell Company is not placed in the worst quadrant, i.e., the useless quadrant (in the useless quadrant, the attribute is of little importance from the customer's point of view, but the desired attribute is offered at a high cost and high performance.) However, Hamrahe Avalcompany is in this quadrant regarding two attributes, 7 and 16. Therefore, according to the fact that the value of the cost base of the first companion company is higher than that of Irancell, and also according to the results of Table 4, it can be said that Irancell is in a better position from the perspective of students according to the attributes examined in this research.

Due to investigating the impact of cost on customer opinions, the performance importance matrix was also checked without the cost dimension, the results of which are given in Table 5.

The difference between Tables 4 and 5, the IPCA matrix with the IPA is as follows:

In the "Low priority" quadrant in the IPA, the specified features are of low importance in terms of importance. Also, the organization is weak in those criteria. In IPCA, the characteristics identified in this quadrant are low importance, performance, and cost. However, in the case that the cost is high, the situation is considered dire in IPCA, which, in addition to the low importance and low performance of its cost, is understood from the perspective of the high customer that this analysis does not exist in IPA.

In the "possible overkill" quadrant in IPA, the specified features are high performance but low importance. On the other hand, the features specified in the "possible overkill" quadrant in IPCA are high performance, low importance, and low cost. If the cost is high, it is placed in the "Useless" quadrant in the IPCA.

In the "Concentrate here" quadrant in the IPA analysis, the specified features are highly important, but the organization has low performance in those features. In contrast, in the IPCA, if the specified features are of high importance, low performance, and low cost, the organization is in the "Concentrate on performance" quadrant, and managers should improve performance. If in the IPCA, the specified features are of high importance and the organization is high in terms of cost and poor performance, it is placed in the "Concentrate on cost and performance" quadrant. In other words, managers should reduce the cost and improve performance."Keep up the good work" quadrant in the IPA, the specified features are of high importance, and the organization also has a high performance in these features. While in the IPCA, the specified features are placed in the "Keep up the good work" quadrant, which in addition to high importance and the high performance of the organization in these features, the customer

perceived cost is also low, but with increased cost, it is placed in the " Concentrate on cost" quadrant and gives recommendations to companies to reduce costs. Moreover, IPA lacks this analysis.

Table 13. importance-performance matrix

The name of the quarter	Dimension status	Irancell	Hamrahe Aval
		Attribute number	Attribute number
Low priority	Low importance, low performance	8-15-17-18	6-8-11-15
Possible overkill	Low importance, high performance	6-7-10-11-16	7-10-16-17-18
Keep up the good work	High importance, high performance	4-13-14-19	13-14-19-20
Concentrate here	High importance, low performance	1-2-3-5-9-20	1-2-3-4-5-9-12

According to Table 5, it can be seen that the attributes 13-14-19 for Irancell company are placed in both the three-dimensional matrix and the two-dimensional matrix in the "Keep up the good work" quadrant. In other words, these attributes have been in a good position regarding cost, and by removing the cost effect, they are still in this dimension. In Irancell company, feature 4, which is in the two-dimensional matrix in the quadrant of "Keep up the good work", is located. However, considering the cost factor in the three-dimensional matrix, it is placed in the "Concentrate on cost" quadrant. Therefore, the best-proposed policy is the cost reduction policy.

In the Hamrahe Aval company, attributes 9 and 12 are located in the two-dimensional matrix in the "Keep up the good work" but in the three-dimensional matrix in the "Concentrate on cost and performance" quadrant. In other words, it is recommended to the managers of the first company to promote performance improvement and cost reduction policies. In this company, attributes 7 and 16 were in the "possible overkill" quadrant of the 2D matrix. However, the 3D matrix is in the "useless" quadrant. In other words, not only the company's good performance for these attributes is unimportant from the customer's point of view, but also the high cost may cause customers to be pessimistic about the company. Therefore, according to this research, managers can make more rational decisions using the developed IPCA tool.

5. Discussion and conclusion

In customer relationship management systems, the importance and performance and cost of service attributes are very important. Failure of managers to use the appropriate tools and methods to understand the needs and expectations of customers will cause a waste of resources and also turn customers away from the organization; Therefore, the use of customer relationship management tools to design products and provide services according to the needs and demands

of different customer segments has become a necessity for organizations. Analyzing the importance of performance is an effective tool for prioritizing service attributes based on customer needs and expectations and identifying the organization's strengths and weaknesses in the market. Nevertheless, this tool examines only two dimensions of importance and performance of a service attribute. Often heard from customers that the ratio of service quality to price is low compared to competitors, and business managers face the problem of buyers' orientation to competitors' services due to the understanding the unfair prices. So in this research, this tool was developed, and also added the cost dimension to measure the service attributes from all three dimensions of importance, performance, and cost. The method presented in this research to prioritize the services of the two companies, Irancell and Hamrahe Aval, in the mobile phone service industry is a new and practical method that, by adding the cost dimension, tries to determine the priorities from the users' point of view based on the three dimensions of importance, performance and there is an expense.

In order to investigate the effect of cost on the results of the survey, in addition to the IPCA, the IPA was also calculated. The comparison results of IPCA and IPA show that the attribute of "Network coverage" in Irancell company is the priority considering the three dimensions of cost, performance, and importance. This attribute has high cost and importance and low performance. Considering that the cost is high in this attribute, it can be expected that regardless of the cost dimension, the priority of this attribute will decrease, and it is clear from the Irancell results table that it has decreased to priority 3. This attribute is placed in the "Concentrate on cost and performance" quadrant in the three-dimensional matrix. Moreover, in the IPA matrix, it is placed in the "Concentrate here" quadrant here. In other words, focusing on performance without paying attention to the cost will increase the cost, and as a result, customer satisfaction will not be achieved.

For Hamrahe Aval users, the network coverage feature is in second place with low performance, high importance, and relatively lower cost than the provincial value. This feature was also ranked second in the IPA and the analysis and performance matrix, it is placed in the focus here quadrant. In the IPCA matrix, it is also placed in the focus on performance quadrant.

As shown earlier, the IPA approach for both companies suggested focusing on this "network coverage" feature. However, the results of the IPCA show that Irancell should reduce the cost in addition to improving performance, which is important from the IPA results that have yet to be discovered. Therefore, according to the results of IPCA, it is suggested that Irancell managers

improve network services and reduce or at least keep the costs constant. Nevertheless, this feature is a performance improvement for the Hamrahe Aval company.

Among other important and valuable features from the customers' point of view can be mentioned the Internet network coverage. The priority of "Internet network coverage" for Hamrahe Aval users has changed from rank 5 in IPCA to rank 7 in IPA, which means that cost is an influential factor in "Internet network coverage" in Hamrahe Aval. In other words, the cost has caused a higher priority (priority 5). In contrast, the results, regardless of the cost aspect, as can be seen, have been placed in a lower priority (priority 7). The proposal of IPCA for this feature is focused on cost; therefore, cost reduction policies are suggested to managers. However, this feature in the IPA approach is placed in the "Keep up the good work" quadrant, and company managers with this approach remain unaware of customer dissatisfaction with the cost and may lose their customers.

The status of the "Internet network coverage" feature is entirely different for Irancell users. The results of Table 4 for Irancell company show that the feature of "Internet network coverage" has high importance, low performance, and low cost, and it is placed in the quadrant of focus on performance. The priority of this feature in terms of IPA is in first place, while this feature is in the fourth place in terms of IPCA. In other words, the low cost of this feature has reduced customer dissatisfaction to some extent, and as a result, the rating of this feature has become the fourth for improvement. Therefore, the best policy for Irancell managers is to improve performance.

Therefore, according to the present research results, adding the cost factor to the importance and performance matrix will better show the existing reality and ultimately lead to better decision-making by managers. According to Table 4, Irancell company is placed in the "Keep up the good work" quadrant regarding four attributes 12-13-14-19, but the Hamrahe Aval company is only in this quadrant in attribute 14.

Also, Irancell performs better than the Hamrahe Aval company in the status of "useless" and "fatal" quarters. According to the results obtained from Table 4 and as seen in Figure 3, most of the attributes in the Hamrahe Aval company have a high cost, so in general, it is suggested that company managers pay special attention to reducing costs. Among the limitations of this research can be pointed out the statistical population, that the prioritization of the service features for two companies, Irancell, and Hamrahe Aval, has been done based on students' opinions. While the customers of these two companies are more than students, it is suggested that a wider statistical population should be selected and investigated in future research.

Disclosure statement

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Evaluation Model of the Systems Thinking Level of the Organization (Case Study: an Iranian Oil Company)

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A B S T R A C T

According to various societal problems, the related problems and issues are expected to be solved gradually. However, by referring to the responsible organizations, we realize that appropriate actions have not been implemented to solve those problems. Regarding the role of systems thinking in organizational learning and improvement, whether the organization is at the proper level of systems thinking to carry out empowering projects should be considered. This research aims to determine an appropriate evaluation model based on experts' opinions to evaluate the organisation's level of systems thinking, which is a research gap regarding the reviewed articles. The proposed research methodology consists of three main phases: defining evaluation indicators and criteria, completing the questionnaire based on the fuzzy Delphi technique and Kendall's coefficient, and determining the organization's systems thinking maturity level. A case study was conducted for an Iranian oil company; it was determined that the company was at the systems thinking confrontation of thoughts level. Therefore, it is necessary to make appropriate arrangements to promote the systems thinking of that company. The main contribution of the research is to provide an evaluation model of the systems thinking level of the organization based on the excellence model of the systems thinking levels of the organization. The unique feature of the proposed model is to pay attention to the thinking style, attitudinal and interactive criteria of systems thinking, including 33 criteria categorized into three leading indicators. This research suggests using the presented model to evaluate the level of systems thinking in different organizations and companies and to implement appropriate approaches to improve the level of systems thinking in organizations and companies before implementing any organizational empowering project.

1. Introduction

According to the existence of various problems in society, such as traffic, pollution, unemployment, traffic, hoarding, lack of housing, inflation, etc., it would be expected that responsible organizations will solve those problems and issues. However, by returning to the relevant organizations, it would be observed that they do not have a coherent plan to solve those problems. Similar to this subject, we observe various manufacturing and service companies in solving customer problems such as quality, productivity, agility and organization improvement. We observe that the improvement projects in those organizations are not successful either in the planning or implementation stage due to inappropriate cooperation of employees, insufficient support of managers and unfavourable organizational culture.

Based on organizational learning and learning organization models, we find out the role and importance of mental models. Regarding the role of thinking style in the mental model and the relationship between different types of thinking styles with systems thinking, organizations have different systems thinking levels. Thinking is a complex form of human behaviour and the highest form of intellectual and mental activity. In other words, it is a cognitive process characterized by codes or signs representing objects and events. Regarding systems thinking, several definitions have been presented, including ability to identify essential system elements and their interdependence (Benninghaus et al., 2019), seeing all elements in a given environment as related to each other (Plack et al., 2018), a holistic thinking model to identify new opportunities in complex systems (Castelle and Jaradat, 2016), Specific skills to solve complex engineering problems with interconnected environmental, social and economic inputs and outputs (Hu and Shealy, 2018), conceptual understanding of system structures (Camelia and Ferris, 2018), an approach to provide potential and comprehensive solutions for managers (Mohammadi Fateh et al., 2021), a cognitive process based on analysis and synthesis in order to achieve a complete and comprehensive understanding of a subject (Fakhimi Hosseinzad and Mirzaei Daryani, 2016), a kind of wise attitude towards the universe and especially the organization as a macro system (Hassanzadeh Naeini, 2022), an integrated and holistic attitude towards the organization (Bagheri et al., 2022), an organized type of thinking that provides a fundamental understanding of the behaviour of a system based on a deep understanding of the structure and actually all the components (Khazri et al., 2021), a framework and method for understanding a problem (Sanei and Shams, 2020) and in general as a holistic thinking (Helali, 2020).

Examining the importance and role of systems thinking in improving the organization has been investigated in various articles. Identifying and evaluating the dimensions and components of managers' systems thinking (Mohammadi Fateh et al., 2021), the impact of systems thinking on project management (Rastgar and Movahedifar, 2021), very important in engineering fields such as chemical engineering and electrical engineering, as complex and interconnected systems of components (Hadgraft et al., 2008), the impact of systems thinking on the effectiveness of managers' performance (Fakhimi Hosseinzad and Mirzaei Daryani, 2016), the necessity of using systems thinking in urban management (Tadbiri, 2021) and especially in solving the problems of metropolises such as urban poverty, lack of infrastructure, informal settlement, growth of pollution, reduction of quality of life and overall growth of instabilities (Mahmoudi, 2021), studying obstacles and benefits of systems thinking (Hassanzadeh Naeini, 2022), investigating the impact of systems thinking in the transformation of organizational culture (Loqhman Starki and Hematian, 2021), the development of systems thinking abilities for the success and survival of organizations (Manzelsaz Kermani et al., 2021), the impact of systems thinking on the continuous improvement of the organization (Ahmadvand et al., 2021), the interrelationship of systems thinking and strategic thinking in the organization (Alipouri, 2021), the application of systems thinking in various work and non-work areas (Khazri et al., 2021), the ability to evaluate and change systems engineering processes according to systems thinking (Bahill and Gissing 1998), and finally the effect of systems thinking on improving organizational performance (Farhadi et al., 2020) are the subjects of the articles that have been presented in the field of systems thinking.

In order to determine the evaluation criteria of systemic thinking, a series of articles was reviewed. Several systems thinking evaluation criteria are presented in the reviewed articles, mentioned in the following table.

Table 14. Systems thinking evaluation criteria mentioned in the reviewed articles

No.	Evaluation criteria of systems thinking	Reference
1	The sequence of events, causal sequence, feedback, interrelations of factors, patterns of relationships	(Cabrera et al., 2021)
2	Dynamic thinking, interaction, mental models, process-oriented, systems logic, continuous learning	(Mohammadi Fateh et al., 2021)
3	Combinational thinking, attention to causes, positivity, no blaming environmental conditions, holistic view	(Helali, 2020)
4	The dynamic and complex interactions between factors	(Shrubsole et al., 2019)
5	Complexity, independence, change, uncertainty and ambiguity, hierarchical vision and flexibility	(Jaradat et al., 2018)

No.	Evaluation criteria of systems thinking	Reference
6	Identification problem, information needs, feedback Loop, reflective ability, predictive ability, incorporation of stakeholder-specific knowledge, socio-political and economic context	(Grohs, 2018; Grohs, 2015)
7	Complexity, integration, interconnectivity, holism, emergence, flexibility, embracement of requirements	(Castelle and Jaradat, 2016)
8	Focusing on the pattern of changes, examining the cycle of cause and effect, dynamic thinking, the effect of structure on system behaviour, process-oriented thinking, balanced system growth, considering the main problems to be caused by the organization, paying attention to the effectiveness of managers' performance	(Fakhimi Hosseinzad and Mirzaei Daryani, 2016)
9	Interconnections, the understanding of dynamic behaviour, systems structure as a cause of that behaviour, and the idea of seeing systems as wholes rather than parts, Feedback loops	(Arnold and Wade, 2015)
10	Recognizing interconnections, identifying feedback, understanding dynamic behaviour, using conceptual models, creating simulation models, testing policies	(Plate and Monroe, 2014)
11	Knowledge structure, experts' reference models, competence development	(Burandt, 2011)

According to the reviewed articles, examining the organisation's systems thinking level has not been addressed, which is a research gap. As well as determining the level of systems thinking of the organization based on an excellence model of the systems thinking of the organization is the specific main goal of this research. Therefore, the main problem of this research is to provide a model to evaluate the level of systems thinking in the organization. The importance and necessity of this research, as stated in the review of various articles, is in the role of systems thinking in solving problems and issues, improving performance, and the success of related improvement projects and actions of organizations. According to the presentation of a model regarding the excellence levels of systems thinking in the organization (Bakhshandeh and Zare Mehrjardi, 2019), the evaluation model of this research is based on the model above.

Therefore, in the next parts of the research, a brief description of the role of mental models in decision-making, the role of the thinking model in the mental model, the relationship between thinking styles and systems thinking, the levels of excellence in organizational systems thinking, and how types of thinking styles are related in the excellence levels of organizational systems thinking, materials have been presented.

2. The relational model of different thinking styles

Organizations are currently dealing with various problems and issues, and a perspective of systems thinking can lead to solving those problems and issues. Figure 1 presents the double-loop learning model proposed in systems thinking and the connection of different components,

especially mental models, in the organization's decision-making.
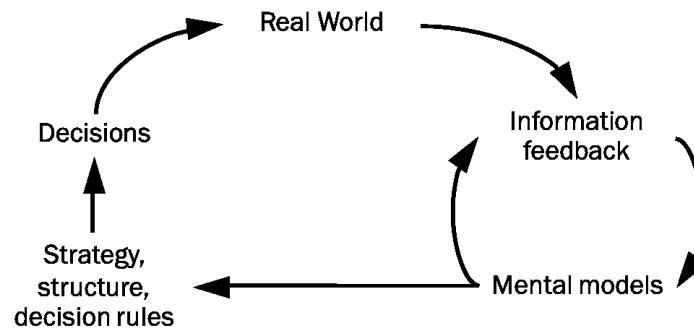
Figure 11. The double-loop learning model proposed in systems thinking (Sterman, 2000)

According to the figure above, mental models are effective in the organization's decision-making in two ways. On the one hand, mental models are effective in analysing information feedback, and on the other hand, in determining strategies, structure and decision-making rules. This relationship is more clearly expressed in Figure 2.
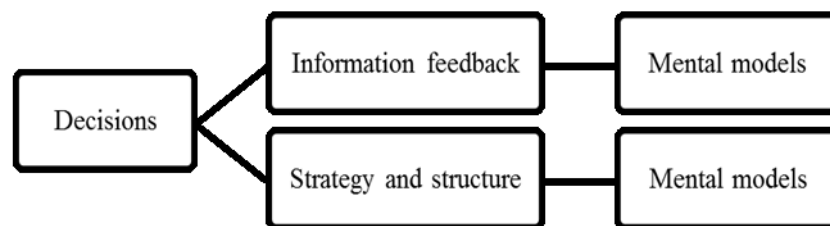
Figure 12. The role of the mental models in the double-loop learning model

As well as, according to the learning organization model presented by Peter Senge (1990) in Figure 3, the role of the mental model is vital in the formation and development of the learning organization.
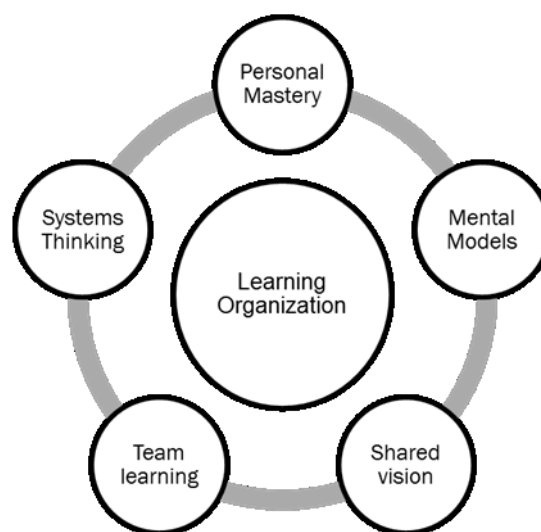
Figure 13. The role of the mental model in a learning organization (Senge, 1990)

Considering the factors of mental models, including values, beliefs, assumptions, and the process of thinking and reasoning (Sterman, 2000), the role of thinking styles in the process of reasoning and the formation of thoughts and even values, beliefs and assumptions, is significant. By reviewing the articles regarding various types of thinking styles, we encounter different styles of thinking, which include such as logical thinking, critical thinking, creative thinking, analytical thinking, combinatorial thinking, reactive thinking, preventive thinking, technical thinking, systems thinking, positive thinking, negative thinking, beneficial thinking, expedient thinking and strategic thinking (Brown, 2019; Cunningham and Macgregor, 2019; Joubert and Swart, 2019; Mahanal et al., 2019). According to the prior studies (Bakhshandeh and Zare Mehrjardi, 2019), the relationship between different types of thinking styles according to DIMATEL[1]'s analytical model is presented in Figure 4.
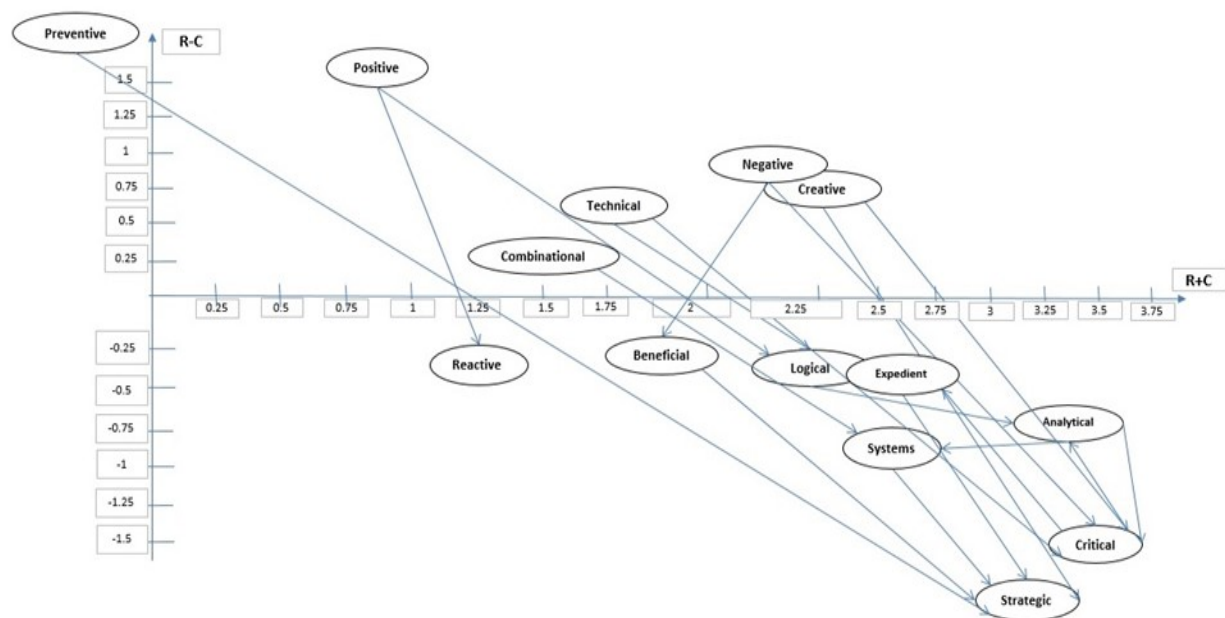
Figure 14. The relationship between different types of thinking styles based on the conducted research
(Bakhshandeh and Zare Mehrjardi, 2019)

In Figure 5, the structured relationship model of the different types of thinking styles according to Figure 4 is presented in a more specific way.

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[1] Decision-Making Trial and Evaluation Laboratory
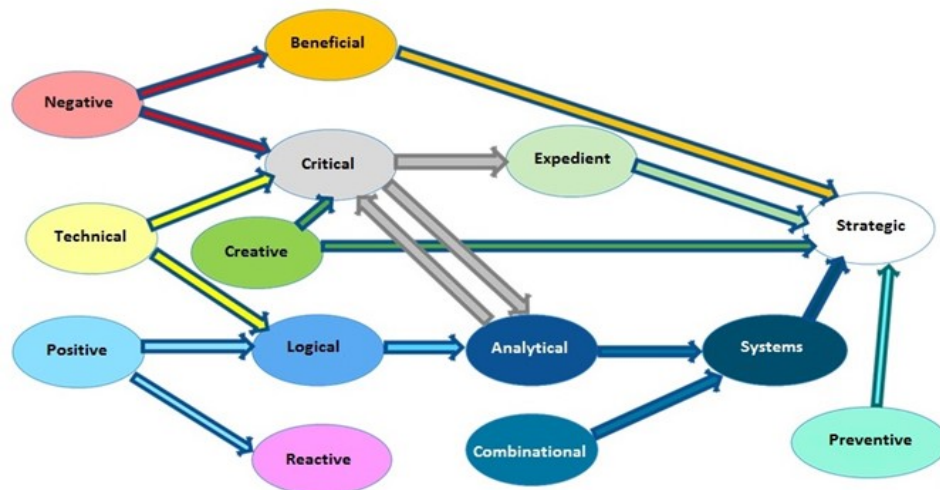
Figure 15. The relationship model of different types of thinking styles

According to the figure above, we understand the relation of different types of thinking styles with systems thinking, especially the role of positive, logical, analytical and combinational thinking in forming systems thinking. Systems thinking is a collection of cognitive tools and perspectives that enable decision-makers to develop logically accurate and complete mental representations of complex environments (Jackson, 2003). Systems thinking has a series of rules that, by applying and paying attention to those cases, a better result can be achieved, which includes issues of not blaming the environmental conditions, understanding the pattern of changes, thinking based on the cause and effect relationship, correctly determining the boundaries of the system, dynamic thinking instead of static thinking, resistance to policies, unwanted consequences and invisible behaviour of social systems, combinational thinking, the importance of how system components interact in performance, the structure of a system that creates behaviour, the importance of leverage points and allowing time for response (Sattari Ardabili and Rahbar Hadi Biglo, 2012).

Based on the content mentioned above, it was found that systems thinking has a special relationship with positive thinking styles such as positive, logical, analytical and combinational thinking. Therefore, considering the role of systems thinking in organizational learning and improvement, the next part concerns the model of excellence levels of systemic thinking of the organization.

3. The model of excellence levels of systems thinking of the organization

According to the research conducted by Bakhshandeh and Zare Mehrjardi (2019), various levels were determined for the excellence of the systems thinking of organizations, which is presented in Figure 6.
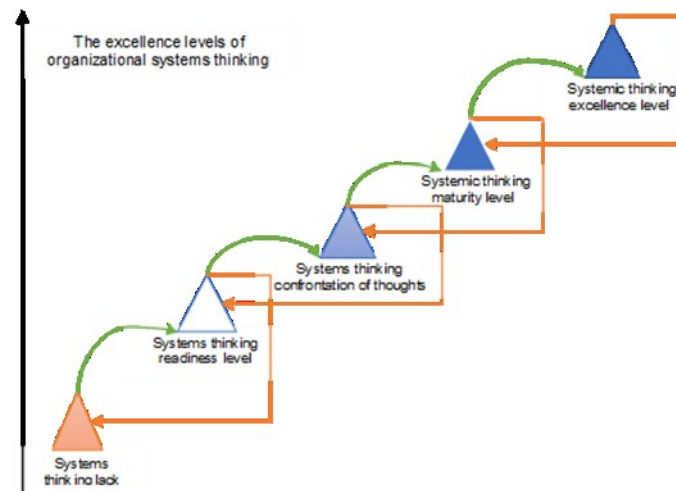
Figure 16. The excellence levels of organizational systems thinking (Bakhshandeh and Zare Mehrjardi, 2019)

A summary of the characteristics of each level in the presented model of systems thinking excellence levels of the organizations based on the types of thinking in the organization is presented below.

(4) The systems thinking lack level: the unique feature of the systems thinking lack level is the predominance of negative thinking styles in the organization. Negative thinking styles include thinkings such as negative, beneficial, pessimistic and critical that do not help the organization are of this type. Undoubtedly, the improvement project is not defined in such organisations, or it would lead to failure. The solution for such organizations is a significant change in personnel or a radical change in the entire organization.

(5) The systems thinking readiness level: If positive thinking styles prevail over negative thinking styles, the organization enters the systems thinking readiness level. However, the amount of positive thinking styles is very low at this level. Positive thinking styles include positive, logical, analytical, and combinational thinking. At this level, the possibility of accompanying the organization in defining and implementing improvement projects is slight, which requires the support of the organization's senior management and coherent planning.

(6) The systems thinking confrontation of thoughts level: this level, compared to the previous level, is that although positive thinking styles prevail over negative thinking styles, however, due to the non-convergence of different thinking and the lack of integration towards systems thinking, the organization has doubts about decisions and implementation of improvement projects. Therefore, we witness a debate between different thinkings, especially negative, critical, analytical, expedient and beneficial, in different people of the organization. In these types of organizations, the probability of success of improvement projects is average. Often in these types of organizations, it is observed that only takes place at the beginning of the work, the cooperation of the personnel and the support of the management in the improvement actions, but in the continuation does not.

(7) The systems thinking maturity level: the special feature of systems thinking is the convergence and integration of different thinking in the direction of systems thinking. Therefore, thinkings such as creative, analytical, combinational, and even critical, expedient and beneficial thinking strengthen systems thinking. In particular, senior managers of the organization have a high level of systems thinking. As a rule, improvement projects and actions are expected to be successfully completed in organisations at this level of systems thinking maturity. However, the danger of such organizations is that they would be unable to maintain their maturity level with environmental changes and may be degraded to a lower level of systems thinking. Therefore, the necessary to stay at this level is to determine and implement the roadmap for the improvement of the organization.

(8) The systems thinking excellence level: the special feature of the excellence level of systems thinking is the realization of the learning organization in different organizational dimensions according to the Senge model (Senge, 1990). In fact, organizations at this level have a suitable level of learning and match the mental models of the organisation's people according to the second loop learning model of Sterman (2000) is facing environmental changes. Therefore, in these organizations, all kinds of thinking in the people and levels of the organization are in the service of systems thinking. Strategic thinking and systems thinking have a high interaction with each other. The most important feature of these organizations in group learning is based on environmental feedback. Although reaching the excellence of systems thinking is great, staying at such a level requires maintaining and monitoring indicators, processes, and business models, primarily based on environmental changes and requirements.

According to the organizational systems thinking excellence model, it was found that in organizations at the level of maturity and excellence of the organizational systems thinking, all styles of thinking are in the service of systems thinking, and in particular, the level of systems thinking is at a high level, especially at the level of senior managers of the organization.

4. Research methodology

The research method includes 3 main phases. The first phase is the phase of defining the evaluation indicators and criteria of systems thinking. The second phase of the research is scoring the criteria and indicators using the fuzzy Delphi technique. The third phase is determining the maturity level of the organization's systems thinking according to the values of indicators (Figure 7).
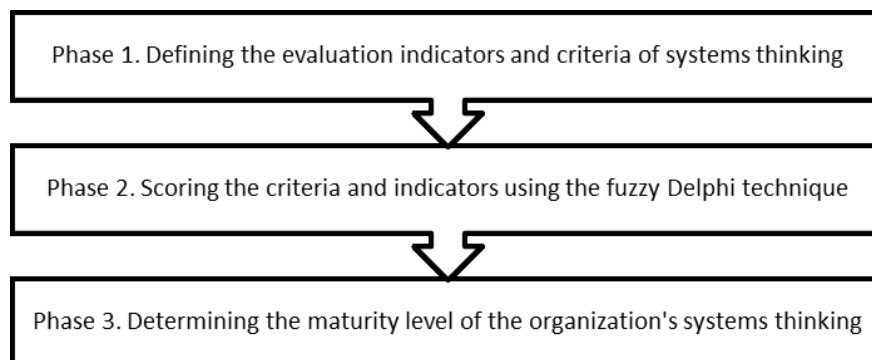
Figure 17. The Phases of Research Method

4.1. Phase 1 of the research methodology

In the first phase of the research, the indicators and evaluation criteria of systems thinking will be determined. Therefore, according to the criteria mentioned in Table 1 and the characteristics of the levels of the excellence model of systems thinking presented in the previous section, three main indicators were determined to evaluate the level of systems thinking of the organization, including the amount of positive thinking styles (such as positive, logical, analytical and combinational thinkings) in the organization, the amount of attitude based on systems thinking

in the organization, and the amount of interaction based on systems thinking in the organization. The reason for choosing the mentioned indicators is to pay attention to the thinking style, attitudinal and interactive criteria of systems thinking. In this regard, 11 evaluation criteria were determined for each indicator, which gives a total of 33 evaluation criteria for all 3 evaluation indicators, according to Table 2.

Table 15. Evaluation criteria of the organization's systems thinking level questionnaire

Index Title	Criterion Number	Criterion Title
The amount of positive thinking styles in the organization	1	I consider myself a person with a positive thinking style
	2	I evaluate positive thinking styles in the company at a good level.
	3	I am willing to change my attitude towards the organization
	4	The root of the organization's problems is not outside the organization.
	5	There is good potential at the company level regarding the organisation's promotion.
	6	There will be a better situation if the organisation's system thinking level is improved.
	7	The organization is progressing in a growing direction.
	8	I consider myself a contributor to the future of the organization.
	9	The organisation's people consider themselves to be involved in the organisation's development.
	10	In the organization, a suitable process is always followed to resolve issues.
	11	Totally, I evaluate the level of positive thinking styles in the organisation's people at a good level.
The amount of attitude based on systems thinking in the organization	12	The organisation's senior managers have a proper overview in analysing the issues of the organization.
	13	The root of organization issues is related to organization, structure, and processes as the cause.
	14	In the analysis of problems, there is a view of the trend of changes from the past until now.
	15	In the analysis of issues, only the events have not been dealt with, and the causes have been investigated and taken into account.
	16	In presenting solutions to problems, leverage points have been considered.
	17	Blaming others is not the right way to solve the problems of the organization
	18	Suitable solutions are used to reduce the resistance of personnel regarding organization development.
	19	A partial attitude would lead to not solving the problems of the organization.
	20	With proper planning of organizational development solutions, it is possible to make the organization successful.
	21	The organization has a suitable road map for the promotion and development of the organization.
	22	Entirely, I evaluate the organization's attitude based on systems thinking at a reasonable level.
The amount of interaction based on systems thinking in the organization	23	The organization has a suitable interactive model for examining its issues.
	24	The reaction speed of the organization's people regarding corporate issues is high.
	25	Employees of the organization have logical thinking in dealing with the issues of the organization.
	26	Experts take necessary actions to analyse the organisation's problems and provide solutions to the managers.

Index Title	Criterion Number	Criterion Title
	27	The managers of the organization make appropriate use of experts' opinions in solving the problems of the organization
	28	It is necessary to use the power of different managers to solve the management issues of the organization.
	29	Proper communication between managers and experts is needed to solve the company's problems.
	30	There are official mechanisms and meetings to investigate company problems and issues.
	31	Only managers do not participate in the decision-making of company issues.
	32	Senior managers of the organization use a high level of systems thinking in solving the organisation's problems.
	33	Overall, the level of interaction based on systems thinking of the organization levels is at a good level.

4.2. Phase 2 of the research methodology

In the second phase of the research, experts' opinions were collected according to the fuzzy Delphi model in several stages, and after converging and reaching a stopping point, validation was done according to Kendall's method. The method used in this research phase is based on the fuzzy Delphi model. Fuzzy Delphi is a method to reach an agreement from the point of view of experts based on the principles of fuzzy logic calculations and fuzzy inference systems. This method uses fuzzy numbers and calculations to better represent the experts' point of view. The most crucial difference between the fuzzy Delphi method and the Delphi method is that in the fuzzy Delphi technique, experts usually present their opinions in the form of verbal variables. The average opinion of the experts and the degree of disagreement between them is determined and in the next step, these data are announced to experts to get new opinions. Therefore, the expert expresses his new opinion according to this information. This process continues until the average opinion of the experts stabilizes (Mostafa Pour, 2021). The fuzzy numbers of the 5-point Likert spectrum of the fuzzy Delphi model are shown in Table 3.

Table 16. Triangular fuzzy numbers of the 5-degree Likert spectrum (Habibi et al., 2015)

No.	Linguistic variable	Triangular fuzzy number	Crisp number
1	Completely important	(0, 0.25, 1)	0.9375
2	Important	(0.15, 0.15, 0.75)	0.75
3	Medium	(0.25, 0.25, 0.5)	0.5
4	Nonsignificant	(0.15, 0.15, 0.25)	0.25
5	Completely nonsignificant	(0, 0, 0.25)	0.0625

In the above table, the crisp numbers are calculated according to the formula related to the Minkowski relation as follows in Equation 1 (Mostafa Pour, 2021):

$$x = m + \frac{\beta - \alpha}{4} \tag{1}$$

Considering that each expert's opinion is in the form of a triangular fuzzy number as follows in Equation 2.

$$\tilde{A}_i = (a_1^i, a_2^i, a_3^i), i = 1, 2, 3, \ldots, n \tag{2}$$

After the experts' opinions are finalized, the fuzzy average of the experts' opinions is done according to Equation 3 (Habibi et al., 2015).

$$\tilde{A}_{ave} = (m_1, m_2, m_3) = \left(\frac{1}{n}\sum_{i=1}^{n} a_1^i, \frac{1}{n}\sum_{i=1}^{n} a_2^i, \frac{1}{n}\sum_{i=1}^{n} a_3^i \right) \tag{3}$$

Due to the fuzzy values, the values are de-fuzzified as Equation 4 (Habibi et al., 2015).

$$A_{ave} = \frac{1}{3}(m_1 + m_2 + m_3) = \frac{1}{3}\left(\frac{1}{n}\sum_{i=1}^{n} a_1^i + \frac{1}{n}\sum_{i=1}^{n} a_2^i + \frac{1}{n}\sum_{i=1}^{n} a_3^i \right) \tag{4}$$

In order to implement the Delphi model, the experts' opinions were first collected based on the above formula. After that, the average of the opinions of the experts was calculated. Then, in the second stage, the opinions of the experts in the first stage and the difference between each expert's opinion compared to the average of the experts' opinions were calculated and announced to them based on Equation 5 (Habibi et al., 2015).

$$\tilde{A}_{ave} - A_i = \left(\left(\frac{1}{n}\sum_{i=1}^{n} a_1^i \right) - a_1^i, \left(\frac{1}{n}\sum_{i=1}^{n} a_2^i \right) - a_2^i, \left(\frac{1}{n}\sum_{i=1}^{n} a_3^i \right) - a_3^i \right) \tag{5}$$

Then, in the second stage, as in the first stage, experts' opinions are calculated according to formulas 1, 2 and 3. If the difference between the values of the two steps according to the following formula is less than the very low threshold (0.1), then the survey is stopped (Mirsepassi et al., 2011).

$$A_{s2} - A_{s1} = \frac{1}{3}[(m_{21} + m_{22} + m_{23}) - (m_{11} + m_{12} + m_{13})] \tag{6}$$

As well as in this research, Kendall's coordination coefficient, which is a non-parametric test, was used to determine the level of consensus among experts. The symbol w represents this coefficient and is between 0 and 1. The value of w determines the degree of coordination and agreement between several rank categories related to n phenomena. This scale shows the rank

correlation between m rank sets. If the Kendall coefficient is zero, there is no complete agreement; if it is one, it means there is complete agreement. The consensus is good if the value of w is higher than 0.5. How to calculate Kendall's coordination coefficient (W) is the Equation 7 (Zare et al., 2023; Kendall, 1939).

$$W = \frac{s}{\frac{1}{12}k^2(N^3 - N)} \tag{7}$$

In the above formula, s is the sum of squares of the deviations of sums of ranks from the mean value, k is the number of experts and N is the number of ranked factors.

4.3. Phase 3 of the research methodology

The maturity level of the organization's systems thinking is determined in the third phase of the research. For this purpose, the systems thinking evaluation indicators are first calculated and then the level of systems thinking is mapped based on the amount of indicators. The method of defining the organization's systems thinking level is determined based on the level of 3 evaluation indicators of the organization's systems thinking in five levels: excellent, very good, good, weak and very weak, according to the following propositions.

- Proposition 1- The basis of systems thinking excellence level is that all 3 indicators of positive thinking styles, an attitude of systems thinking and interaction based on systems thinking should be at an excellent level.
- Proposition 2- The basis of systems thinking maturity level is that one of the 3 indicators of positive thinking styles, the attitude of systems thinking and interaction based on systems thinking, should be at a very good level and the rest at a very good or excellent level.
- Proposition 3- The basis of systems thinking confrontation of thoughts level is that if one of the 3 indicators of positive thinking styles or the attitude of systems thinking or the interaction based on systems thinking is at a good level.
- Proposition 4- The basis of systems thinking readiness level is that if one of the 3 indicators of positive thinking styles or attitude of systems thinking or interaction based on systems thinking is at a weak level, the rest are weak or very weak.
- Proposition 5- The basis of systems thinking lack level is that all 3 indicators of positive thinking styles, the attitude of systems thinking and interaction based on systems thinking are very weak.

According to the above propositions, the levelling of the systems thinking of the organization is based on the levelling of systems thinking indicators, according to Table 4.

Table 17. How to level the systems thinking of the organization

No.	The amount of positive thinking styles in the organization index score	The amount of attitude based on systems thinking in the organization index score	The amount of interaction based on systems thinking in the organization index score	The level of systems thinking
1	very weak	very weak	very weak	systems thinking lacks the level
2	Weak	very weak/weak	very weak/weak	systems thinking readiness level
3	very weak/weak	Weak	very weak/weak	
4	very weak/weak	very weak/weak	Weak	
5	good	*	*	systems thinking confrontation of thoughts level
6	*	good	*	
7	*	*	good	
8	very good	very good/excellent	very good/excellent	systems thinking maturity level
9	very good/excellent	very good	very good/excellent	
10	very good/excellent	very good/excellent	very good	
11	excellent	excellent	excellent	systems thinking excellence level

In the case of determining a score of 1 for the 5-point scale of systems thinking evaluation indicators, the way to determine the level of systems thinking of the organization is based on the values of systems thinking indicators, according to Table 5.

Table 18. The score for determining the level of systems thinking based on the values of the indicators

No.	The amount of positive thinking styles in the organization index score	The amount of attitude based on the systems thinking index score	The amount of interaction based on the systems thinking index score	The level of systems thinking
1	less than 0.2	less than 0.2	less than 0.2	systems thinking lacks the level
2	between 0.2 and 0.4	less than 0.4	less than 0.4	systems thinking readiness level
3	less than 0.4	between 0.2 and 0.4	less than 0.4	
4	less than 0.4	less than 0.4	between 0.2 and 0.4	
5	between 0.4 and 0.6	*	*	systems thinking confrontation of thoughts level
6	*	between 0.4 and 0.6	*	
7	*	*	between 0.4 and 0.6	
8	between 0.6 and 0.8	between 0.6 and 1	between 0.6 and 1	systems thinking maturity level
9	between 0.6 and 1	between 0.6 and 0.8	between 0.6 and 1	
10	between 0.6 and 1	between 0.6 and 1	between 0.6 and 0.8	
11	between 0.8 and 1	between 0.8 and 1	between 0.8 and 1	systems thinking excellence level

5. Results and interpretation - a case study

In order to accurately assess the exact level of the organization's systems thinking, a questionnaire was prepared. The statistical population of the research was the managers and experts of an Iranian oil company, and according to the presentation of systems thinking training workshop in that company, a questionnaire was distributed among a sample of 14 experts of that company. It should be mentioned that there were 14 experts, including 12 at the senior expert level and 2 at the junior expert level, of which 6 participants were managers and 8 were

technical employees of that company.

According to the research method, the first phase was to determine the criteria and indicators for evaluating systems thinking, which was determined according to the research method. In the second phase of the research, a questionnaire was designed to determine the score of the evaluation criteria specified in the first phase. After presenting the questionnaire and summarizing the opinions, the evaluation scores of each criterion were calculated using the fuzzy Delphi technique. According to the fuzzy Delphi technique, the collection stages included 3 stages. In the following, the evaluation scores of the 3-stage criteria are presented separately for the 3 evaluation indicators of the systems thinking level. The scores of the evaluation criteria for the index of positive thinking styles in the organization are shown in Table 6.

Table 19. Evaluation scores of the index of positive thinking styles in the organization

No.	Criterion Title	First Stage Score	Second Stage Score	Difference between the first and Second Stages	Third Stage Score	Difference between the Second and Third Stages
1	I consider myself a person with a positive thinking style.	0.78	0.75	0.03	-	-
2	I evaluate positive thinking styles in the company at a good level.	0.65	0.63	0.02	-	-
3	I am willing to change my attitude towards the organization	0.76	0.78	0.02	-	-
4	The root of the organization's problems is not outside the organization.	0.73	0.65	0.08	-	-
5	There is good potential at the company level regarding the organisation's promotion.	0.65	0.69	0.04	-	-
6	There will be a better situation if the organisation's system thinking level is improved.	0.69	0.75	0.06	-	-
7	The organization is progressing in a growing direction.	0.56	0.62	0.06	-	-
8	I consider myself a contributor to the future of the organization.	0.68	0.77	0.09	-	-
9	The organisation's people consider themselves to be involved in the organisation's development.	0.45	0.58	0.13	0.61	0.03
10	In the organization, a suitable process is always followed to resolve issues.	0.56	0.59	0.03	-	-
11	Totally, I evaluate the level of positive thinking styles in the organisation's people at a good level.	0.58	0.70	0.12	0.68	0.02

The scores of evaluation criteria of the attitude index based on systems thinking are shown in Table 7.

Table 20. Evaluation scores of the attitude index based on systems thinking

Criterion No.	Criterion Title	First Stage Score	Second Stage Score	Difference between the first and Second Stages	Third Stage Score	Difference between the second and Third Stages
12	The organisation's senior managers have a proper overview in analysing the issues of the organization.	0.62	0.67	0.05	-	-
13	The root of organization issues is related to organization, structure, and processes as the cause.	0.65	0.78	0.13	0.82	0.04
14	In the analysis of problems, there is a view of the trend of changes from the past until now.	0.56	0.62	0.06	-	-
15	In the analysis of issues, only the events have not been dealt with and the causes have been investigated and taken into account.	0.55	0.60	0.05	-	-
16	In presenting solutions to problems, leverage points have been considered.	0.53	0.55	0.02	-	-
17	Blaming others is not the right way to solve the problems of the organization	0.52	0.65	0.13	0.63	0.02
18	Suitable solutions are used to reduce the resistance of personnel regarding organization development.	0.48	0.42	0.06	-	-
19	A partial attitude would lead to not solving the problems of the organization.	0.45	0.50	0.05	-	-
20	With proper planning of organizational development solutions, it is possible to make the organization successful.	0.44	0.68	0.24	0.72	0.04
21	The organization has a suitable road map for the promotion and development of the organization.	0.40	0.45	0.05	-	-
22	Entirely, I evaluate the organization's attitude based on systems thinking at a good level.	0.43	0.56	0.13	0.49	0.07

The scores of evaluation criteria for the interaction index based on systems thinking are shown in Table 8.

Table 21. Evaluation scores of the index of interaction based on systems thinking

Criterion No.	Criterion Title	First Stage Score	Second Stage Score	Difference between the first and second stages	Third Stage Score	Difference between the second and third stages
23	The organization has a suitable interactive model for examining its issues.	0.37	0.32	0.05	-	-
24	The reaction speed of the organization's people regarding corporate issues is high.	0.52	0.55	0.03	-	-
25	Employees of the organization have logical thinking in dealing with the issues of the organization.	0.48	0.62	0.14	0.65	0.03
26	Experts take necessary actions to analyse the organisation's problems and provide solutions to the managers.	0.27	0.45	0.18	0.53	0.08
27	The managers of the organization make appropriate use of experts' opinions in solving the problems of the organization	0.22	0.36	0.14	0.33	0.03

Criterion No.	Criterion Title	First Stage Score	Second Stage Score	Difference between the first and second stages	Third Stage Score	Difference between the second and third stages
28	It is necessary to use the power of different managers to solve the management issues of the organization.	0.33	0.64	0.31	0.66	0.02
29	Proper communication between managers and experts is needed to solve the company's problems.	0.26	0.31	0.05	-	-
30	There are official mechanisms and meetings to investigate company problems and issues.	0.29	0.38	0.09	-	-
31	Only managers do not participate in the decision-making of company issues.	0.32	0.38	0.06	-	-
32	Senior managers of the organization use a high level of systems thinking in solving the organisation's problems.	0.36	0.42	0.06	-	-
33	Overall, the level of interaction based on systems thinking of the organization levels is at a good level.	0.44	0.32	0.12	0.35	0.03

Due to the difference in the values of the steps, if this difference is less than 0.1, the continuation of the questioning of the experts for the relevant criterion has been stopped. Therefore, the stages of questioning the experts regarding the evaluation scores of the organization's systems thinking criteria have been continued up to three stages. Also, the Kendall index has been calculated at each survey stage (Table 9).

Table 22. Kendall index value of the steps of the delphi method

Step	Kendall index value
1	0.415
2	0.565
3	0.583

According to Table 9, Kendall's index level in the first stage of the survey based on the Delphi technique was less than acceptable. Still, in the second and third stages of the survey, this level changed to an acceptable level.

In the third phase of the research, the organisation's systems thinking level should be determined based on the values of evaluation criteria and indicators. Therefore, the amount of each index has been calculated based on the average values of the determined criteria presented in Table 10.

Table 23. Final scores of systems thinking evaluation indicators

Index No.	Index Title	The final index score
1	The amount of positive thinking styles in the organization	0.68
2	The degree of attitude based on systems thinking	0.59
3	The amount of interaction based on systems thinking	0.44

Based on the table above, the levels of the organization's systems thinking evaluation indicators are as follows.

- The index of the amount of positive thinking styles in the organization is at a very good level.
- The index of attitude based on systems thinking is at a good level.
- The index of interaction based on systems thinking is at a good level.

Therefore, according to the evaluation scores of 3 indicators of systems thinking of the oil company and since one of these indicators is at a good level, based on the model in Table 3, it can be concluded that the mentioned company is not located in the maturity and excellence levels of systems thinking. It is at the "confrontation of thoughts with systems thinking" level. The practical suggestion of the research for that company is to improve to systems thinking maturity level as below:

1. To increase the interaction based on systems thinking in the organization according to the scores of related criteria that are less than 0.6, including criteria No. 23, 24, 26, 27, 29, 30, 31, 32, 33.
2. To promote the attitude based on systems thinking in the organization through providing appropriate training, optimizing processes and systems, etc., especially regarding the scores of related criteria that are less than 0.6, including criteria No. 16, 18, 19, 21, 22.
3. To advance the organisation's positive thinking styles, especially with respect to the scores of related criteria that are less than 0.6, including criteria No. 10.

If the items mentioned above are implemented, we will certainly see an improvement in the organisation's systemic thinking level.

6. Conclusion

In this research, we sought to provide a suitable evaluation model to determine the systems thinking level of the organization. Considering the presentation of an excellence levels model of organizational systems thinking in 5 levels, including systems thinking excellence level, systems thinking maturity level, systems thinking confrontation of thoughts level, systems thinking readiness level and systems thinking lack level, we were looking for appropriate evaluation indicators and criteria to evaluate systems thinking and determine the level of systems thinking of the organization. According to the concepts of systems thinking, in this research, 3 indicators of positive thinking styles in the organization, attitude based on systems thinking and interaction based on systems were determined, and 11 criteria for each indicator and a total of 33 criteria were determined. Then, the model for determining the level of systems thinking was proposed. In the continuation, the evaluation of the systems thinking level of the organization related to one of the oil companies where a systems thinking course was held according to the opinions of experts based on the fuzzy Delphi model. Based on the analysis

results of 14 company experts, it was found that the company is at the level of confrontation of thoughts with systems thinking. The practical suggestion of the research for that company is to increase the interaction based on systems thinking, to promote the attitude based on systems thinking, and at the same time advance the positive thinking styles in the organization through providing appropriate training, optimizing processes and systems, in order to raise the level of systems thinking to a higher level of maturity in systems thinking. The main contribution of the research is to provide an evaluation model of the systems thinking level of the organization based on the excellence levels model of organizational systems thinking, as well as the list of criteria and indicators necessary for promotion. The special feature of the proposed model is to pay attention to the thinking style, attitudinal and interactive criteria of systems thinking. Research suggestion to use the presented model to evaluate the level of systems thinking in different organizations and companies and continue implementing appropriate training and approaches to improve the level of systems thinking in organizations and companies before execution of any organizational improvements project such as business analysis and improvement, process analysis and improvement and organization development.

Disclosure statement

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A Dynamic Model for Predicting the Impact of Vaccine Avoidance and Health Protocols on the Covid-19 Outbreak

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A B S T R A C T

The COVID-19 pandemic is one of the most critical issues in the world today. Although many countries have been able to control the infection, much research is still needed to uncover the complex dynamics of virus transmission. This study aimed to utilize a mathematical model for analyzing epidemiological data of infectious diseases, aiming to comprehend their behavior, predict future trends, and investigate the influence of external factors on key indicators. This model extends the Susceptible-Exposed-Infected-Recovered (SEIR) framework by incorporating additional populations, such as vaccinated individuals, asymptomatic cases, and hospitalized patients. It also developed dynamics related to vaccination avoidance behavior and adherence to health protocols. It is coded in MATLAB 2018-b software and is executed for 360 days. The results of the simulation showed that it is not possible to achieve the desired level of immunity from vaccine injection without following health protocols. On the other hand, considering the level of infection, increasing the participation rate in receiving vaccines and reducing the population of vaccines can control the epidemic. Therefore, a change in social behavior and an increase in the amount of vaccination can increase the awareness of society in reducing the avoidance of vaccination and improving compliance with health protocols.

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1. Introduction

In December 2019, in Wuhan, China, a new strain of the coronavirus (COVID-19) was identified as an epidemic in humans and gradually spread throughout the world to become a pandemic (Zhonghua et al., 2019). About 20 months after its release, the world has seen several mutations in the virus. More than 230 million people have been infected, and 4.8 million have died from coronavirus (Makhoul et al., 2021). During all this time, experts and scientists from different countries have tried to find ways to fight the virus. Some of them have succeeded in producing approved vaccines, such as Pfizer, Moderna, Astrazneka, and Sinopharm, and have made them available to others (Saporta-Keating and Nyquist, 2021; Mallapaty and Callaway, 2021; Mallapaty, 2021; Waheed et al., 2022). Experts emphasize various preventive measures to combat the spread of COVID-19. Alongside widespread vaccination, these measures include strict adherence to health procedures and protocols, practicing social distancing, and avoiding gatherings, particularly weddings and mourning ceremonies. It is observed that vaccines are not welcomed by some people in the world, and protests are even initiated by them to avoid receiving them. (Dror et al., 2020, Chou and Budenz, 2020, Chadwick et al., 2021, Loomba et al., 2021). The results of a survey by the European Foundation for the Improvement of Working and Living Conditions (Euro found) show that nearly a quarter of those surveyed are reluctant to receive the vaccine. The vaccine avoidance population in Western Europe is much smaller than in Eastern Europe, with less than 10% of Danes and Irish people opposed to vaccination, with the highest vaccine avoidance rates in Bulgaria at 59%, France at 38%, and Austria at 34% (eurofound, 2023). In Iran, the results of a poll conducted by the National Planning Office of the Institute of Culture, Arts, and Communications of the Ministry of Culture and Islamic Guidance show that 73.7% of Iranians are willing to be vaccinated against coronavirus (ricac.ac, 2023). However, doctors prefer the benefits of vaccination to its side effects. In addition to emphasizing vaccination, they also require adherence to health protocols until the complete eradication of the coronavirus. Iran also pursued a policy of producing and importing vaccines. The outbreak of the delta species, the inability to mass-produce, and the non-compliance of countries' parties to the vaccine contract marked a dark summer in the country (Barmparis and Tsironis, 2020, Khankeh et al., 2021, Basiri and Koushki, 2021). Considering the recent advancements and rapid implementation of the overall vaccination plan, the significant impact of administering vaccines against COVID-19 allows for making predictions based on dynamic modeling, with a specific emphasis on the vaccinated population. Several methods have been used to predict the COVID-19 trend. Some researchers have used Autoregressive Integrated

Moving Average (ARIMA) statistical models and other regression methods to predict the spread of new epidemics.

Mathematical modeling as a powerful tool for epidemiological analysis of infectious diseases to understand the behavior and forecast and study the impact of external factors on its indicators is clear. The use of differential equations and the design of dynamic systems based on classical models Susceptible-Infected-Recovered (SIR) and SEIR have been considered by many researchers. The researchers used the developed SIR model to determine and predict the peak times of COVID-19 cases and to study the epidemic trend in China, Italy, and France (Fanelli and Piazza, 2020). We can mention the new models presented based on the SEIR model for predicting, examining, and analyzing the behavior of COVID-19 disease (Li et al., 2021b, Partohaghighi and Akgül, 2021). One of the approaches that play a crucial role in controlling the disease and public health in the world is the quarantine strategies defined by the World Health Organization during this COVID-19 epidemic. A group of studies developed classical dynamic mathematical models to predict the impact of quarantine policy on the disease process (Chung and Chew, 2021, Cui et al., 2020, Díaz and Henríquez, 2021, Zhu and Zhu, 2021, Kristjanpoller et al., 2021).

Vaccination has been used as another pandemic control strategy in two ways in mathematical modeling. Some researchers have considered vaccination as a rate variable affecting the recovery of susceptible individuals (Amouch and Karim, 2021, Asgary et al., 2020, Libotte et al., 2020). As the vaccination process increased, the vaccinated population was considered a state variable in the dynamically developed models. The proposed model of SIRDV in (Usherwood et al., 2021), with susceptible (S), vaccinated (V), infectious (I), recovered (R), and deceased populations (D), incorporates two different dynamic population behaviors of the level of caution and sense of security It is possible to predict the course of the disease by vaccination and considering these two behaviors. Foy et al. (2021) and Boudaoui et al. (2021) simulated the SEIR model with a structure of mass communication with social contact matrices to investigate the relative reduction of mortality and the development of vaccine allocation strategies based on the prioritization of different age groups and the interaction of these strategies with simultaneous drug interventions have been performed. Regarding the implementation of the overall vaccination plan, the positive effect of vaccination on COVID-19 is significant to provide predictions based on dynamic modeling focusing on the vaccinated population.

In line with the importance of the present study and learning from the past for future predictions, it should be noted that the global spread and epidemic of the new coronavirus

(COVID-19) has put one of the most critical conditions in front of the country's health service delivery system. The difficulty of managing this crisis, especially with Iran's special conditions, the unknown nature of the disease, and the lack of sufficient experience, has provided the field with creativity and various innovations. Innovative actions, favorable forecasts, valuable experiences in the case of management with smart and innovative approaches and turning into explicit knowledge, and the design of strong decision support and forecasting systems for decision-making are valuable reserves at one's disposal. The health service delivery system of the country and the world will be placed. In addition, the genetic mutations of the virus and the occurrence of several disease peaks in our country and the world confirm the need for scientific planning. The spread of the coronavirus in the world and unpreparedness to face it have caused many problems in the healthcare system of many countries. In this regard, epidemic models are developed, and other components are added.

2. Methodology

Mathematical modeling based on dynamic equations is a powerful tool for epidemiological analysis of infectious diseases to understand behavior, predict, and study how external factors affect them. Compared to statistical methods, it can provide a more precise mechanism for epidemic dynamics and essential information about the disease. The need for this is especially evident in diseases such as COVID-19, where the main epidemiological parameters are unknown or need to be understood more mechanically. Widespread vaccination against coronavirus worldwide is necessary to study vaccinated individuals' behavioral dynamics. In this regard, in this study, vaccinated individuals are considered, and the SEIR model is developed inspired by the models presented in Mallapaty (2021) and Mallapaty and Callaway (2021). As shown in Figure (1), the overall SEIR framework is expanded by the model, which adds vaccinated, asymptomatic, and hospitalized populations and combines dynamics based on vaccination avoidance behavior and observance of health protocols as important defining features of this study.
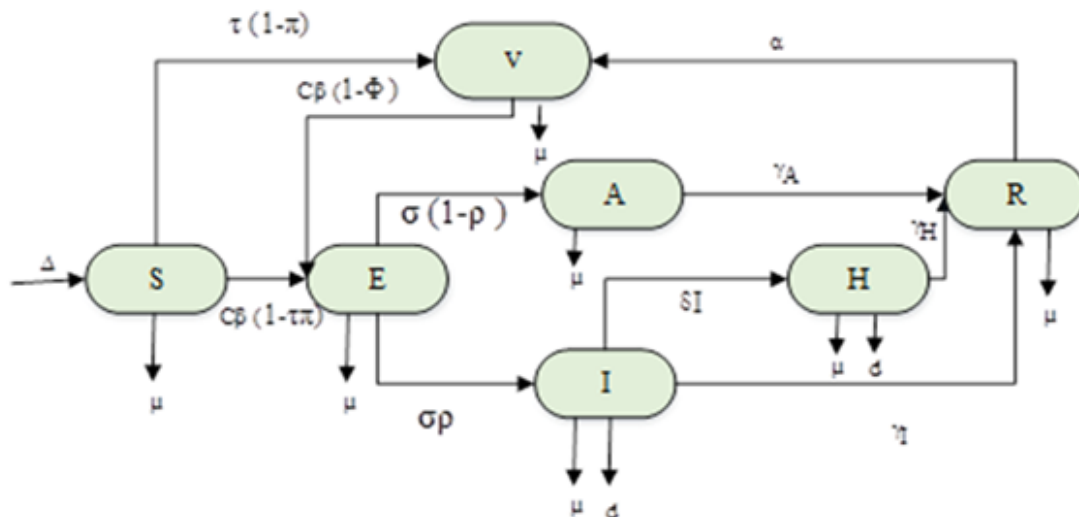
Figure 18. *SVIAHR Model*

This model consists of seven sections: susceptible (S), exposed (E), vaccinated (V), infectious (I), asymptomatic(A), hospitalized(H), and recovered (R). They show S, V, I, A, H, R, and time-dependent fraction variables concerning the area's total population (Table 1). We describe the model starting from the susceptible population. Individuals can be exposed to infection at a rate of β, susceptible populations that are not exposed to the vaccine depending on the availability of the vaccine. Another factor influencing the vaccination rate is the level of public participation or vaccine avoidance. Vaccinated populations, such as the susceptible population, can also be exposed, depending on the vaccine's effectiveness. In this study, the effectiveness of the vaccine (φ), the rate of vaccine availability (τ), and the rate of vaccine avoidance (π) were assumed. The exposed population is transferred to symptomatic patients with a transfer rate of $\sigma(1-\rho)$ and with a transfer rate of $\sigma\rho$ to the compartment of symptomatic patients, which σ is the rate of transmission from E to I and ρ the probability of symptoms in patients. The proportion of asymptomatic infection in the population equal is θ. A fraction of the infected population needs to be hospitalized and is transferred to the H compartment at a rate of δ_I. Populations I, A, and H recover with the transfer rates $\gamma_I . \gamma_A . \gamma_H$. Recovered patients can be vaccinated at a rate of α after 42 days. We consider the natural mortality rate μ for all populations in and corona deaths for the population H, I with d rate. In the present study, τ is the vaccine availability rate and π the vaccine avoidance rate. The simultaneous dynamics of observance of health protocols and vaccination avoidance rates are investigated by performing several different simulations.

Table 24. Compartments of the SVIAHR model with its definitions

Compartments	Definitions
Susceptible population (S)	The ratio of the population who are susceptible to getting infected if they are exposed to it.
Exposed population (E)	The ratio of the population exposed to the infection, but they have no clinical symptoms.
Vaccinated population (V)	The ratio of the population fully vaccinated against Covid-19 relative to the total population
Iinfectious population(I)	The ratio of the population who are infectious and they have clinical symptoms.
Asymptomatic population(A)	The ratio of the population with no clinical manifestations of COVID-19, such as fever, cough, sore throat and other self-perceived or clinically identifiable symptoms and signs.
Hospitalized population (H)	The ratio of the population who were admitted to the hospital due to the infection of covid-19
Recovered population (R)	The ratio of the population who are recovered from the infection and are temporarily immune from the infection.

The rate of reinfection caused by the virus is very low, and its effect can be ignored at the time scale of our study. Due to the uncertainty about the availability of vaccines that will be used in the future, to predict, we have used a fixed vaccination rate and implemented the model according to the rate of different vaccine avoidance under several scenarios. The SVIAHR model for a region /population is described by Equations (1) to (7).

$$\frac{dS}{dt} = \Delta - c\beta(1 - \tau\pi)S(I + \theta A) - \tau(1 - \pi + \mu)S \tag{1}$$

$$\frac{dE}{dt} = c\beta(1 - \tau\pi)S(I + \theta A) + c\beta(1 - \varphi)V(I + \theta A) - (\sigma + \mu)E \tag{2}$$

$$\frac{dI}{dt} = \sigma\rho E - (\delta_I + \gamma_I + d + \mu)I \tag{3}$$

$$\frac{dA}{dt} = \sigma(1 - \rho)E - (\gamma_A + \mu)A \tag{4}$$

$$\frac{dV}{dt} = \tau(1 - \pi)S - (1 - \varphi)c\beta V(I + \theta A) - \mu V + \alpha R \tag{5}$$

$$\frac{dH}{dt} = \delta_I I - (\gamma_H + \mu + d)H \tag{6}$$

$$\frac{dR}{dt} = (\gamma_I I + \gamma_A A + \gamma_H H) - (\alpha + \mu)R \tag{7}$$

The summarizes the interpretation of the parameter embedded in the SVIAHR model in Table 2.

Table 25. The summarizes the interpretation of the parameters

Parameter	Definitions	Estimated Mean Value	Unit and calculation	Data Source
Δ	Birth rate	0.00004	$\dfrac{\overline{birth}}{population}\Big/ yearly\ day$	(Sabteahval, 2023)
μ	Natural death rate	0.000013	$\dfrac{\overline{death}}{Population}\Big/ yearly\ day$	(Sabteahval, 2023)
c	Contact rate	9.191	Number of individuals Direct contact per person per day	(Shakhany and Salimifard, 2021)
β	Probability of transmission per contact	0.102	-	(Shakhany and Salimifard, 2021)
τ	availability vaccination rate	1/80	Estimated	Experts
π	Vaccine avoidance rate	-	Scenario base	Experts
ρ	Probability of having symptoms among infected person	0.8683	-	(Usherwood et al., 2021)
σ	The transition rate of E to I or A	1/7	1/day	
δ_I	The transition rate of I to H	0.00006	Probability of hospitalized × 1/day	
γ_A	The recovery rate of A to R	0.0714	1/day	
γ_I	The recovery rate of I to R	0.06821	Probability of Recovery ×1/day	
γ_H	The recovery rate of H to R	0.974×1/7	Probability of Recovery × 1/day	(Jabari, 2022)
θ	Infectiousness rate due to A class	0.0205	-	(Usherwood et al., 2021)
d	The death rate from coronavirus	0.026×1/7	Probability of due covid × 1/day	(Jabari, 2022)
φ	The effective rate of vaccination	0.88	Average of several vaccines	
α	The transition rate of R to V	1/42	1/day	Experts

2.1. Data description

The parameters used to implement the model include demographic information on Iran, global rates of COVID-19, and the opinions of health professionals. Birth and natural death rates are calculated based on pre-release data on COVID-19 in Iran (Waheed et al., 2022). Because of the rate of access to the vaccine, the degree of effectiveness in different virus strains is unknown. According to health system experts, it is considered approximately according to Table 2. Recovery rates are based on the average duration of normal recovery or hospitalization and the likelihood of recovery or death from COVID-19 according to data from the delta virus species at the fifth peak of the disease in August and June 2021 in Iran (Chou and Budenz, 2020). Other transfer rates are based on COVID-19 global data, some of which have been modified by experts due to the special conditions of Iran and the widespread prevalence of Delta species. Other transfer rates are based on COVID-19 global data (Chou and Budenz,2020, Usherwood et al., 2021), some of which have been modified by experts due to the special conditions of Iran and the widespread prevalence of Delta species. One of the most critical parameters of the model is β_0 to investigate the effect of health protocol compliance on the

system in several scenarios, its initial value is defined as the product of the contact rate in the probability of disease in each contact.

3. Simulation results

The presented model is coded in MATLAB 2018-b software and is executed for 360 days in exchange for Table 2 parameters. It is solved to the ode45 function on the time interval [0 360] with initial values (0.980876, 0.0001, 0.00002, 0.000004, 0,0,0). In this research, simulation is performed with two approaches. In the first step, the rate of vaccination avoidance is fixed, and the rate of disease transmission is assumed to be variable to affect the observance of health protocols. In the second step, the vaccination rate changes by considering the appropriate rate of β. The results are presented in Figure 2. Due to the small scale of the hospitalized variable, this figure is not displayed and presented separately in Figure 3(a).
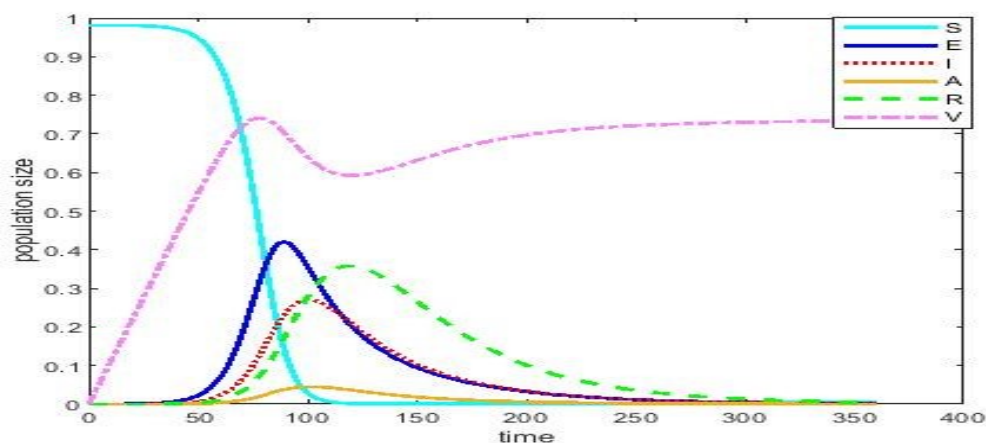
Figure 19. The behaviour of model variables

Next, it is evaluated the effect of increasing the observance of health protocols on the implementation of successful vaccination. Proper vaccination procedures can greatly help manage possible corona peaks in the future. But we must not forget that this period of normalization of the people can also create major problems for the adopted policies and challenge some decisions. Serious adherence to health protocols, social distancing, and reduced contact rates to plan vaccination are necessary. In this study, the extent of changes in contact rates and adherence to health protocols, which reduces the incidence of the disease, on the behaviour of the designed system, with emphasis on indicators of hospitalized, infected, and vaccinated populations, are examined. We examine the effect of β reduction on system behavior, assuming that vaccination avoidance rates and availability are constant. Increasing the observance of hygienic protocols, i.e., using a mask, a physical distance of 1.5 to 2 meters, no formation of any accumulation, proper ventilation, and avoiding the presence of a large

number of people indoors can help reduce the incidence rate β. In this section, all simulations are performed for $\pi = 0.75$. The system is designed and implemented for $\beta_0, 0.75\beta_0, 0.4\beta_0$. Figure 3. (a) shows the simulation results of hospitalized cases. Figure 3. (b) shows the proportional population of infected and vaccinated for $\beta_0, 0.75, \beta_0, 4\beta_0$. Table (3) shows values of Max hospitalized, Mean hospitalized, Peak time of hospitalized, Max Infected, Mean Infected, Peak time of Infected and Max vaccinated for comparison.

Table 26. Values of indices

Comparison indices	β_0	$0.75\beta_0$	$0.4\beta_0$
Max hospitalized	1.02e-05	1.004e-05	9.207e-06
Mean hospitalized	3.473e-06	3.428e-06	2.73e-06
Peak time 0f hospitalized	56	64	90
Max Infected	0.3121	0.3052	0.2782
Mean Infected	0.1132	0.1078	0.0823
Peak time 0f Infected	49	57	84
Max vaccinated	0.2565	0.3313	0.5528

In Figure 3. (a). hospitalized.S1, S2 and S3 shows hospitalized for $\beta_0, 0.75\beta_0, 0.4\beta_0$ respectively. According to the values presented in the second and third lines of Table 3 and Fig. 3. (a) By reducing the amount β, their number decreases and causes a time delay in the maximum of patients. In Figures 3. (b) a proportional representation of the vaccinated and infected population is performed under three scenarios.
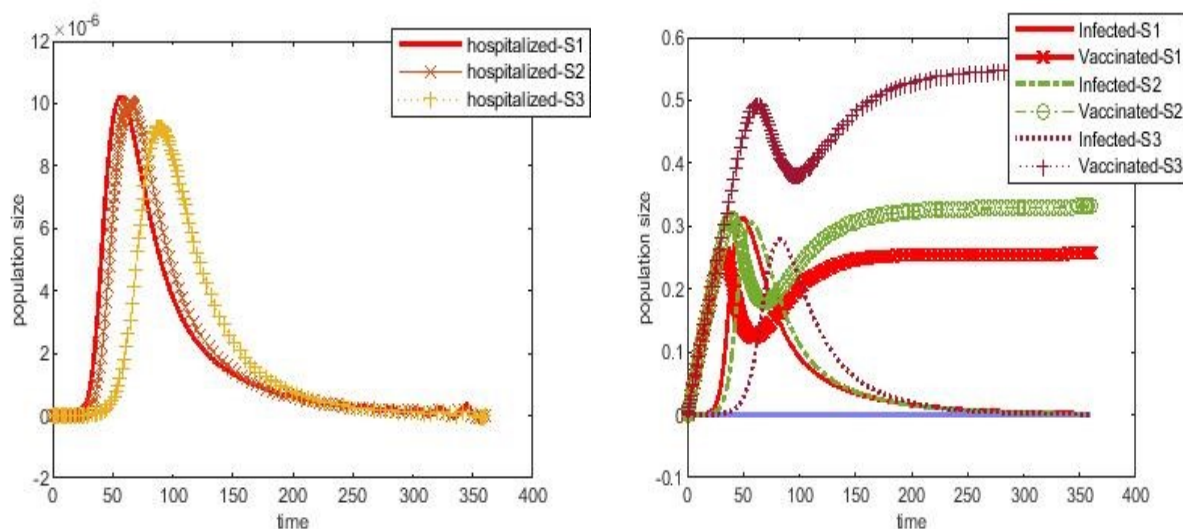
(a) Hospitalized population in 3 scenarios   (b). Proportional population I and V in 3 scenarios
Figure 20. Proportional population h, I and V in 3 scenarios

Careful examination of figures and comparison of Table 3 values indicate that the reduction in the rate β as a result of following the health protocols as much as possible will reduce the number of hospitalized and infected, the delay in the peak time, and the successful implementation of the general vaccination plan.

The next is Simulating the behaviour of vaccine-avoiding people. The goal of general vaccination against COVID-19 disease is to control the epidemic that has engulfed the world. Negative publicity for vaccine opponents can challenge public vaccination. Reasons for people avoiding the vaccine are distrust and fear of vaccine side effects, the ineffectiveness of vaccines against coronavirus, false and negative propaganda about infection and death after vaccination of coronavirus in cyberspace, and lack of trust in governments due to the economic aspect of vaccine production. In traditional societies, cultural and religious factors can increase the number of people vaccinated. Therefore, the impact of people's participation in receiving the vaccine on the system is examined under several scenarios. The simulation is performed for $\beta = 0.3$ and $\pi = 0.3, 0.2$ and 0.1. based on the model's parameters, according to Figure 4, the vaccinated population is approximately equal to the vaccination rate of 0.3 and 0.2, approximately equal to the rate of 0.57 and 0.63, respectively.
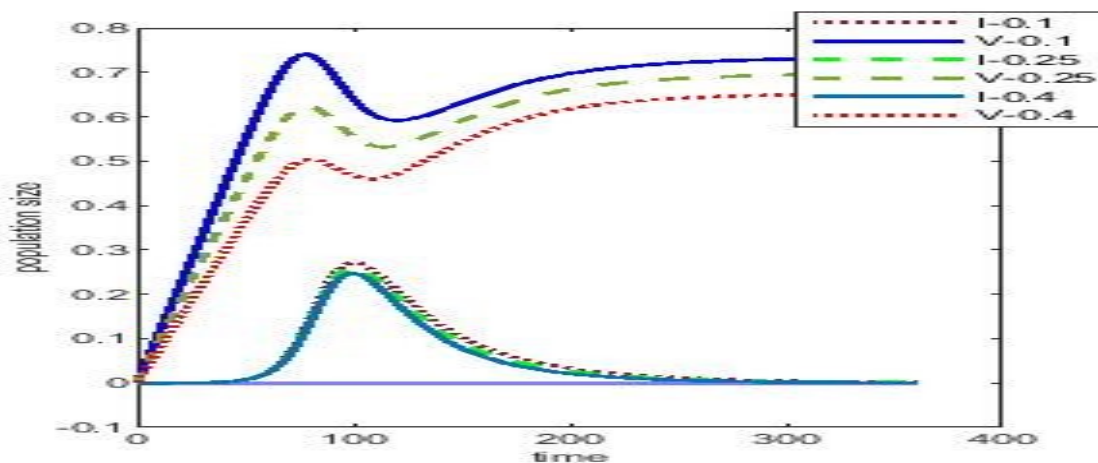
Figure 21. Proportional population I and V for 3 avoidance Vaccine rate

As shown in the figure above, the level of the vaccinated population cannot provide relative safety at the community level. Reducing the avoidance vaccine rate to 0.1 will bring the level of immunity to an optimal level with about 0.74 vaccinated populations. Therefore, observing the health protocols to reduce the disease transmission rate to 0.3 and increasing the awareness rate to reduce the number of vaccine avoiding people will lead to the successful implementation of the general vaccination plan.

In this research, a comprehensive dynamic system based on differential equations was designed, and the effect of the mentioned social behaviours on the system was investigated. Compared to other studies (Usherwood et al., 2021, Li et al., 2021a) and (Poonia et al., 2022), the designed model includes more variables, such as the vaccinated population and asymptomatic patients. In addition, the relationship between behaviour and disease outbreaks

has been investigated in several scenarios. With a forward-looking approach, the designed model simulates the outbreak of the disease, and according to the presented results, health managers can make the necessary preparations to face the disease, and policymakers can make appropriate decisions regarding social behaviours.

4. Conclusion

In the world today, The COVID-19 pandemic is one of the most critical issues. Although some countries have controlled the infection, much research is still needed to uncover the complex dynamics of virus transmission. In this paper, a mathematical model for the dynamics of COVID-19 with an emphasis on vaccination was developed. One of the critical problems of some communities in implementing the general vaccination plan to control the virus is non-participation in receiving the vaccine and the existence of a vaccine-avoiding population. Another issue is the feeling of security caused by receiving the vaccine and not following the health protocols. These two behaviours were considered effective parameters of the disease process. Due to the social disruption in following the health instructions, the reduction of social capital and the lack of social trust cause the health instructions to not be tracked. Some people think that they don't get infected and get normal after the vaccine when this isn't the case. The incidence is very low, but it is still possible. Health protocols such as using a mask, observing social distancing, avoiding everyone, and being in closed spaces should also be observed after vaccination. None of these vaccines provides 100% certainty in preventing infection. The simulation results showed that it is not possible to achieve the desired level of safety resulting from vaccine injection without observing health protocols. On the other hand, due to the rate of infection, increasing the rate of participation in receiving vaccines and reducing the population of vaccine vaccines can control the epidemic. Common causes of immunization in people who do not believe in COVID-19 disease believe in the human mind's fabrication; the model of this study focuses on the vaccinated population and the behavioural parameters that affect it. Lack of accurate knowledge about vaccine availability rates, vaccine efficacy and other factors causes some ambiguity. Therefore, although a few predictions from our study are essential, all possible uncertainties must be considered. Due to the appropriate distribution of vaccine injections in Iran, it is assumed that the rate of access to the vaccine and its effectiveness is considered constant. With access to more accurate information, new data can be incorporated directly into our model for more accurate results. Another point is that the infection rate is also assumed to be constant, and the results are shown per peak. It is suggested that the proposed model be

implemented according to the vaccinated population and the effects of the possible mutant virus in the next peak on the future of the population and the health care system. We expect informed policy development and successful vaccination to contribute to public health. Presenting the results of the model and the effect of changes in social behaviour and increasing the rate of vaccine injection can cause awareness in the community to reduce the rate of vaccination avoidance and increase compliance with health protocols.

Researchers in management, epidemiology, dynamic systems, and data science can benefit from the suggestions presented in their future research. In the disease process simulation model, it is suggested to make predictions by considering all possible uncertainties. In this study, the vaccination rate is constant during the study period; it is suggested to consider the vaccination rate as a time-dependent function. Simulating the model for different regions and paying attention to the fact that the vaccine access rate varies from one region to another can be considered. Also, the effectiveness of different types of vaccines, the different effects of vaccines against different mutated strains of coronavirus and the population's age groups can help develop the model. Using the artificial intelligence approach to estimate the model's parameters increases the predictions' accuracy. It is suggested that mathematicians discuss the uniqueness of the solution using the existing theorems to prove the stability of the dynamic system.

5. Research limitations

In the dynamic model for predicting the course of the disease, due to the lack of available information, the model's parameters are mainly taken from previous studies and the initial hypothetical values are included in the model. The lack of access to a suitable computer system has made it difficult to implement modelling in a situation closer to reality.

Simulation in compartments modelling has been done for cases where other parameters are constant, and by scenario changing the same parameters entered into the model, the future situation of the epidemic has been predicted if another crisis happens at the same time as the parameters change in the real world research will not be very effective.

In this research, it has been tried to define human factors in the form of mathematical language, and for this case, it is assumed that the parameter values are constant during the simulation period, but human behaviour is very unpredictable.

Disclosure statement
No potential conflict of interest was reported by the author(s).

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Analyzing and Prioritizing Customers' Quality Requirements by Combining k-means, Kano Model and Fuzzy AHP

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A B S T R A C T

Customer satisfaction is the main condition for competing in the global market. In the international market, customer requirements or needs have been turned into a primary concern for organizations. Also, numerous studies have shown that customer satisfaction has a positive effect on organizations' profitability. In order to attract and retain customers, it is essential to identify and classify their requirements and predict them for organizations. Ideally, every organization should fully understand each of its customers, which is impossible in practice, so this study has used the market segmentation technique to identify customer needs. After the market segmentation, appropriate services should be provided for each segment to achieve customer satisfaction. One of the powerful techniques in this field is the Kano model. Investing in the motivational needs of customers and obtaining their satisfaction requires identifying the most important motivational needs. Therefore, in this study, the combinations of the K-means, Kano, and fuzzy analytic hierarchy process (FAHP) methods are used.

1. Introduction

Delivering high-quality services to customers is the key success factor in service industries. Monitoring and improving services' quality should be grown by increasing competition for efficiency improvement and business volume. In manufacturing and service industries, quality improvement is an essential factor affecting customer satisfaction and purchase intention (Meesala and Paul, 2016). In the international market, customer requirements or needs have become a primary concern for organizations. To survive in this situation, companies can no longer rely solely on high-volume and low-cost production. Instead, to maintain competitive advantage, they make an effort to meet customers' needs and achieve customer satisfaction. Companies deal with a big challenge to satisfy the variety of customers' requests. Therefore, identification and meeting customers' needs are fundamental factors in designing and developing a product or service and maintaining the market position (McKay et al., 2001). To satisfy customer demands, it is necessary to understand the service quality required by customers and provide them with services based on such requirements (Huang et al., 2015). Providing high-quality services for customers and satisfying them is a primary and major challenge to the management of hotels in the modern hospitality industry (Kuo et al., 2016). One of the techniques to improve customer service quality while measuring customer satisfaction is the Kano model (Kano et al.,1984). The significant difference between the Kano model compared with other quality models, namely the importance-performance analysis (Martilla and James, 1977), technical and functional quality model (Gronroos, 1984), or service quality gap model (Servqual) (Zeithaml et al., 1990) is that it regards the influence of attribute performance on the overall level of customer satisfaction as nonlinear and asymmetric. Besides, it allows a complex perspective on separate attributes and their contribution to customer satisfaction.

Considering the above-mentioned points, it is vital to identify the customers' needs and satisfy them. On the other hand, because of different demographic characteristics, customers will express different preferences for service characteristics (Lai and Wu, 2011). And this is because hotels' guests include people from different cultures that probably have different needs and values (Liu and Shih, 2005). Therefore, ideally, every organization should know each of its customers thoroughly which is not possible in practice. Market segmentation allows similar customers to be included in one market segment, so managing and understanding these segments is much easier than identifying individual customers' needs (Shahin et al., 2021). The k-means method can be used for market segmentation as one of the clustering methods (Wu, 2006).

After market segmentation, it is possible to identify the needs of different groups of customers in different market segments by the Kano model to provide services compatible with each customer's needs. All customers' quality requirements are not of equal importance because of design constraints, time, budget, and so on in a competitive environment (Fung et al., 2003). Therefore, customers' quality requirements are prioritized in attractive categories. Given the facilities and limitations of the organization, more facilities were provided for high-priority customers' quality requirements in attractive categories. The hierarchical analysis process can be used to prioritize the quality requirements of different customers. Therefore, the main purpose of this study is to provide a combined model of clustering, Kano, and FAHP methods for recommending customer-based services.

The rest of this paper is organized as follows: In the second section, related studies are presented and the paper's contributions have been provided. In the third section, the proposed research methodology, including the clustering method, Kano model, and FAHP, is described concisely. In the fourth section, the application of the proposed model in a four-star hotel in the tourist city of Mashhad is explained. Finally, the conclusion and future research are stated.

2. Literature review

2.1. Customer satisfaction

Many studies have been done on the topic of customer satisfaction. Customer satisfaction is the customer's evaluation of the goods and services, whether they meet their needs and expectations or not (Schiffman et al., 2010; Levens, 2012; Kotler & Armstrong, 2012). Satisfaction levels may vary depending on whether consumers rate a feature as a minimum requirement or value-added (Gregory and Parsa, 2013). Topfer (1996) believes that customer satisfaction does not depend on the type of organization's business activity or its market position but depends on the organization's ability to provide the expected quality of a customer.

2.2. Quality of service

Service quality is a complex concept. It is difficult for consumers to evaluate the quality of services before consumption, during, and after it considering various attributes and characteristics of rendered services (Bougoure & Neun,2010). Service quality is considered as a key factor in customer satisfaction. There is extensive literature on the relationship between service quality and customer satisfaction (Gregory and Parsa, 2013; Gunarathne, 2014). According to Parasuraman et al. (1988), customer' judgment is defined as the superior nature of a service compared with similar services which consider its salient advantages. Ong (1998)

defined service quality as the overall quality levels of consumption assessed by customers' subjective judgments.

2.3. Studies related to customer satisfaction and service quality

The literature review for writing the current paper was centered on customer satisfaction and service quality, which have been done with different methods, specifically in service industries. Several studies have used the Servqual model as a measurement tool for service quality. For example, Akbaba (2006) has used the Servqual model in the hotel industry to measure the service quality of a hotel in Turkey. Stefano et al. (2013) evaluated the service quality of a large hotel through the fuzzy Servqual and fuzzy AHP.

For many years, customer satisfaction had been focused on a one-dimensional structure. It means that the higher quality of a product is received by a customer, the greater customer satisfaction will be gained and vice versa. In comparison, kano's two-dimensional quality model states that all quality components are not the same. (Kano et al.,1984). In other words, customers do not necessarily treat all attributes equally, and sometimes adding an attribute to a product can cause them dissatisfaction (Gregory and Parsa, 2013). Some papers applied the Kano model to consider customers' satisfaction and their needs in hotels. Yang et al. (2009) also applied the Kano model in hotels. Using this model, they examined the frequency of using service items to propose a strategic pricing model. The application of the proposed model is demonstrated in a case studying a 5-star hotel in Taiwan. Lee and Chen (2006) used the Kano model to measure service quality in hot spring hotels in Taiwan. They assessed that customers with different attributes, such as demographics and travel modes, had various views about service quality. Ban and Mester (2014) tested a two-dimensional quality model, proposed by Noriaki Kano, in an actual situation of four hotels from Oradea. Their research illustrated the degree of global satisfaction of the surveyed clients and categorized quality attributes into the three main areas (plus one) suggested by Kano. Zobnina and Rozhkov (2018) conducted a study to test the Kano model for identifying satisfaction drivers, developing segmentation, and customer profiling in service segments.

The Kano model also can be used in service organizations to perceive customers' needs and define new requirements for improving their services. Most of the time the Kano model is integrated with other tools. For example, some studies have used a combination of Kano and AHP or ANP methods. Momani et al. (2014) provided a systematic approach for determining and prioritizing the healthcare quality attributes that affect patients' satisfaction using FAHP

and the Kano model. Alroaia and Ardekani (2012) Represented a combination algorithm of AHP and Kano to prioritize influential factors on customer needs in e-banking. Also, several studies have used the combination of Kano and quality function deployment(QFD). Tan and Shen (2000) suggested a method to integrate the results of the Kano model into the QFD. Then, they proposed an approximate conversion function to adjust the ratio of improvement to any customer need in the QFD. Chaudha et al. (2011) also proposed a new method for integrating the results of the Kano model into the QFD and represented a new formula for the improvement ratio. Chang and Chen (2011) used a combination of the Kano model and QFD to explore customers' contacts with brands in a business hotel based on customers' perspectives and service providers. Kuo et al. (2016) also integrated the Kano model and QFD in a hotel in Taiwan to rank attributes and suggest technical attributes. Bayraktaroğlu and Özgen (2008) used the Kano and AHP models to recognize, categorize and weigh user requirements for library services; then, employ QFD to identify visible marketing strategies.

Identifying customer needs and satisfying them is of utmost importance. On the other hand, because customers have different demographic characteristics, they will have different preferences for service characteristics (Lai and Wu, 2011). Therefore, some researchers used clustering methods to analyze customers' quality requirements. Dursan and Caber (2016) used RFM (Recency, Frequency, and Monetary) analysis and clustering in three Hotels in Turkey. According to its results, RFM effectively clusters the group, and hotel managers can generate new strategies for improving their abilities in customer relationship management (CRM). Some papers applied a combined model of the Kano and Cluster analysis. Rezaeian et al. (2016) identified customers' requirements in Nyazco online shopping. They clustered these customers using two k-means algorithms and a fuzzy kano model to provide product features based on each customer's needs. Chang et al. (2009) proposed an approach to training artificial neural networks to group users into different clusters. Then, they applied the well-established Kano method to extract users' implicit needs in different clusters. Huang et al. (2015) used cluster analysis to effectively segment customer characteristics into the maintenance and repair of motor vehicles and then applied the Kano model, which is different from the traditional measurement of customer preference. Table 1 presents a comprehensive overview of previous studies that has focused on analyzing customers' quality requirements.

Table 27. Literature summary

Author	Methodology	Study subject	Context
Akbaba (2006)	Servqual	Service quality	Hotel industry
Grobelna & Marciszewska (2013)	Servqual	Service Quality	Hotel Sector
Alroaia & Ardekani (2012)	AHP and Kano	Customer needs	E-banking
Ban & Mester (2014)	Kano two dimensional	Touristic services	Hotels' clients
Bayraktaroglu and ozgen (2007)	Kano model, AHP & QFD	Customer requirements	Library services
Chang & et al., (2016)	Data mining methods	Tourist loyalty	Hotel
Chang & Chen (2011)	Kano model and QFD	Brand contacts	Hotel business
Dominici & Palumbo (2013)	Kano model	customer satisfaction	Hotels
He et al., (2017)	fuzzy Kano's model	Customer Requirements	Manufacturer
Gupta & Srivastava (2012)	Customer satisfaction	Customer satisfaction	Hotel industry
Kuo et al.,(2015)	Kano and QFD	Service Quality	Hotel
Chen et al., (2018)	Kano Model and QFD	Service Quality	Restaurants

2.4. Conclusions of literature and research contributions

Previous studies have demonstrated that the Kano model can be used for categorizing attributes in terms of consumer preferences because of eliminating the Servqual shortcomings in the Linear relationship assumption between an attribute performance and customer satisfaction. On the other hand, clustering allows companies to behave differently in various market segments (Golsefid et al., 2007). Therefore, the present research has used a combined model of the Kano and K-means to study the quality requirements of provided services for hotel customers. In the next step, FAHP was used to prioritize elements of quality requirements. The literature review shows that no studies have used motivational needs prioritization. Therefore, managers can make the right decision to invest in motivational needs based on the results of priorities. Overall, investing in the most important motivational needs can result in customer satisfaction and profitability. In contrast, most previous studies have used the QFD, FAHP, or AHP methods to develop the Kano model. For example, Gupta and Srivastava (2012), Chang and Chen (2011), and Kuo et al. (2015) have used the Kano model combined with the QFD. Alroaia and Ardekani (2012), Wongrukmit and Thawesaengskulthai (2014), and Momani et al. (2014) have used the Kano model combined with AHP, or FAHP. Also, the literature review had not used the combined model of k-means and the Kano to study the satisfaction and needs of customers in the field of hotel service and hospitality. However, the combination of the Kano and clustering methods has been used out of hotel services and hospitality in the studies of Mozafari et al. (2016), Rezaeian et al. (2016), Abdolahi et al. (2017), Huang et al. (2015), and Chang et al. (2009). Therefore, the mentioned points have distinguished the present study from others due to using a combined model of k-means, kano, and FAHP methods in the hospitality industry and hotel services.

3. Research methodology

In this study, to assist top hotel managers in categorizing customers' requirements and improving their planning according to what they want, the K-means and Kano models were used. First, hotel clients were clustered using the K-means method. In the next stage, after interviewing with the managers and experts, 15 qualitative requirements were identified; then, they were used in the framework of the Kano questionnaire. According to the Cochran formula, 168 questionnaires were distributed among customers. After the fulfillment and collection of questionnaires, the Kano analysis was done to extract customers' preferences. In the final step, the FAHP method was used to prioritize customers' requirements in the quality categories derived from the Kano. The steps of the proposed method in this paper are presented in Figure 1.
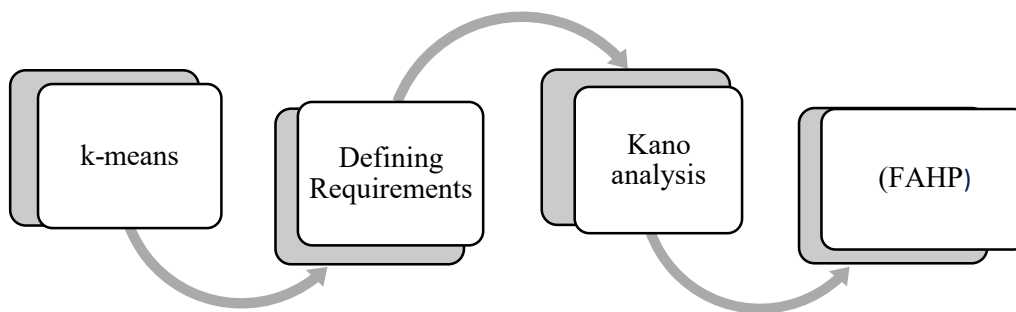
Figure 22. Research steps

3.1. K-means algorithm

Due to the significant volume of data, that must be analyzed, data mining tools have been increasingly used in recent years. It can be stated that two essential tasks of data mining are classification and clustering. One of the most known algorithms being used in clustering is the K-means algorithm applied in this paper. The K-means algorithm is used to cluster customers of hotels to perform a more accurate examination of customer requirements; so that customers' needs are checked in each cluster to improve customer satisfaction and loyalty. The K-means algorithm has been described below.

The K-means is one of the most used clustering algorithms, which partitions data into the K-clusters (MacQueen, 1967). It starts partitioning by randomly selecting k samples from the input data set as initial centroids. Then, clusters are formed repeatedly by measuring the distances of all samples in the input space. Compared with the other clustering algorithms, K-means does not require a huge number of parameters, and by using some heuristic approaches, it becomes computationally efficient (Güngör & Özmen, 2017). The steps of the K-means algorithm are defined as the following (Larose and Larose, 2014):

- Step 1: Ask the decision-maker how many clusters (k) the data set should be divided into.

- Step 2: Assign k records randomly as the initial cluster of central locations.
- Step 3: For each record, find the closest cluster center.
- Step 4: For each k cluster, find the cluster centroid, and update its central location to the centroid's new value.
- Step 5: Repeat steps 3 to 5 until the convergence or termination phase.

3.2. The Kano model

One of the most accepted tools for recognizing and categorizing customers' needs is the Kano model proposed by Dr. Kano (Kano, 1984). Kano is a two-dimensional quality model that applies functional and dysfunctional questionnaires. It also applies a 5×5 evaluation table, as a guidance tool, and is applicable to be utilized in a lot of research and case studies (Lee and Huang, 2009). In this research, the Kano model has been implemented in each k-means cluster for a more accurate survey of customer requirements.
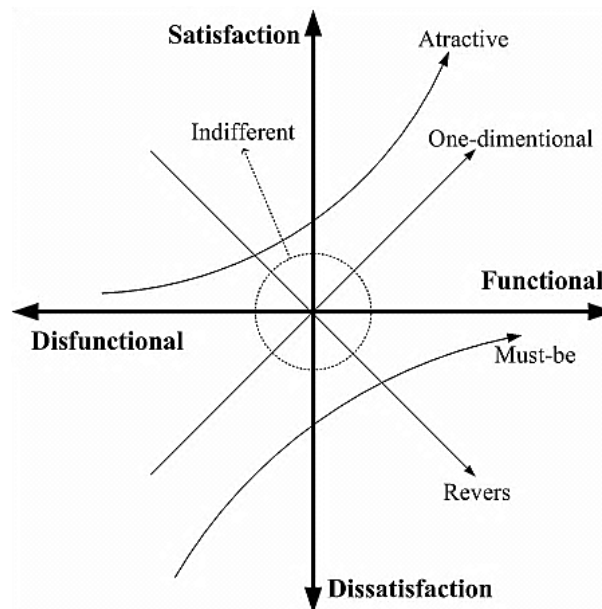
Figure 23. Kano model dimensions

Thus, the Kano model defines the relationship between the implementation and non-implementation of customers' requirements in a product/service. According to its impact on customer satisfaction, it provides five categories of products/services namely, One-dimensional, Attractive, Indifferent, Questionable, and Reverse (Rashid et al., 2010). The Kano model dimensions are represented in Figure 2.

The first dimension of the model, the vertical axis in Figure 2, measures customer satisfaction, and its horizontal axis measures their requirements function. Five categories of the Kano model are defined as follows.

- *Attractive category*: Implementing an attractive requirement in a product/service leads to higher customer satisfaction, but its absence does not lead to customer dissatisfaction.
- *One-dimensional category*: Embedding a one-dimensional requirement in a product/service increases customer satisfaction, and its absence leads to customer dissatisfaction.
- *Must-be category*: The absence of a mandatory requirement leads to customer dissatisfaction, but its presence does not increase customer satisfaction.
- *Indifferent category*: Whether an indifferent requirement is embedded or not in a product/service, neither leads to satisfaction nor dissatisfaction.
- *Reverse category*: Implementing a reverse requirement in a product/service results in customer dissatisfaction. In contrast, its absence leads to customer satisfaction (Rashid et al., 2010).

The Kano questionnaire is provided to realize the feelings of potential customers about the presence or absence of a requirement in a product/service compared with its alternatives. It is possible to achieve this purpose by asking two functional and dysfunctional questions for each requirement. After collecting the questionnaires, an overall attitude toward categorizing customers' requirements is concluded through Table 2 (Lee and Huang, 2009).

Table 28. Kano evaluation

| | Dysfunctional | | | | | |
Dislike	Live-with	Neutral	Must-be	Like		
O	A	A	A	Q	Like	
M	I	I	I	R	Must-be	
M	I	I	I	R	Neutral	Functional
M	I	I	I	R	Live-with	
R	R	R	R	R	Dislike	

A=Attractive, I=Indifferent, M=Must-be, O=One-dimensional, Q=Questionable, and R=Reverse

According to the mentioned points, 168 questionnaires were distributed among customers in a four-star hotel in Mashhad. The questionnaire includes 15 questions about customers' requirements, which are presented in Table 6. As a result, the Kano model classifies the customers' requirements into five categories. The implementation of the Kano model in each cluster shows how the presence or absence of a requirement in a product/service affects customer satisfaction in a cluster.

3.3. *Fuzzy analytical hierarchy process (FAHP)*

In the conventional method of AHP, decision-makers are asked to compare two criteria with the Crisp numerical values to indicate their preferences. Moreover, it is supposed that decision-makers are confident about their preferences, which is not always true. To reduce the effects of uncertainty and vagueness in decision-making, the FAHP approach is used in which the Fuzzy set theory and its operations are integrated with the conventional AHP. The FAHP is designed so that decision-makers can express their uncertain judgments and preferences through linguistic values rather than the Crisp ones used in the conventional AHP. These linguistic

values are transformed into fuzzy membership functions representing fuzziness and uncertainty. The steps of the fuzzy AHP technique using Chang's method are presented as follows:

Step 1-Prioritizing criteria, sub-criteria, and options

In this paper, the FAHP is implemented to categorize the variables into three groups Must-be, One-Dimensional, and Attractive. It should be noted that the variables of each group are already identified by the Kano method.

Step 2- Formation of paired comparison tables and responses.

Paired comparisons are made based on the spectrum presented in Table 3. Table 3 represents the linguistic values and their triangular fuzzy numbers (TFNs) (Vahidnia et al., 2009) used in the FAHP; these numbers can be changed and evaluated to fit the decision maker's fuzziness.

Table 29. Triangular fuzzy number of linguistic variables

Linguistic value	TFNs
Equally important	(1,1,2)
Moderately important	(2,3,4)
Important	(4,5,6)
Very Important	(6,7,8)
Absolutely important	(8,9,9)

Step 3- Calculating the incompatibility rate of paired comparisons.

In this step, the incompatibility rate of paired comparisons should be assessed. If this rate is less than 0.1, it means that the paired comparison has proper stability and consistency.

Step 4 - Merging paired comparisons.

When several respondents have answered paired comparisons, the Geometric mean method is used to merge them and obtain a merged pairwise comparison matrix.

Step 5- Calculating weights with Chang's analysis method.

First, based on Equation (1), S_i values can be obtained for each row of the fuzzy pairwise comparison matrix, Where i represents the row numbers, and j denotes the column numbers.

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1} \tag{1}$$

M_{gi}^{j} is a triangular fuzzy number for the pairwise comparison matrices. The values of $\sum_{j=1}^{m} M_{gi}^{j}, \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]$ and $\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1}$ can be calculated using Equations (2), (3), and (4) respectively.

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j , \sum_{j=1}^{m} m_j , \sum_{j=1}^{m} u_j \right) \tag{2}$$

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{i=1}^{n} l_i , \sum_{i=1}^{n} m_i , \sum_{i=1}^{n} u_i \right) \tag{3}$$

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i} , \frac{1}{\sum_{i=1}^{n} m_i} , \frac{1}{\sum_{i=1}^{n} l_i} \right) \tag{4}$$

In the above equations, l_i, m_i and u_i are the first, second, and third components of fuzzy numbers, respectively.

STEP 6: Computing the magnitude of S_i comparison with each other.

In general, if $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ be two triangular fuzzy numbers, the magnitude of M_1 compared with M_2 can be defined as follows in Equation (5).

$$V(M_2 \geq M_1) = hgt \, (M_1 \cap M_2) = \mu_{M_2}(d) = \begin{cases} 1 = if \ m_2 \geq m_1 \\ 0 \ if \ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} \ otherwise \end{cases} \tag{5}$$

On the other hand, the magnitude of a triangular fuzzy number from k, as another triangular fuzzy number, can be obtained through Equation (6).

$$V(M \geq M_1, M_2, \dots, M_k) = V[(M \geq M_1) \ and \ (M \geq M_2) \ and \dots (M \geq M_k)]$$
$$= \min V(M \geq M_1) \quad i = 1,2,3,\dots,k \tag{6}$$

STEP 7: Computing weights of the criteria and alternatives in the pair-wise comparison matrix (Equation (7)).

$$\acute{d}(A_i) = \min V(S_i \geq S_K) \quad k = 1,2,\dots,n \quad , k \neq i \tag{7}$$

STEP 8: Calculating the final weight vector.

The weight vector calculated in the previous step must be normalized to calculate the final one.

4. Results

According to the former methods and steps, the proposed method is implemented in a four-star hotel in Mashhad, a city with numerous hotels, which makes the competition more challenging. In the following, the results of the proposed combined methods, i.e., K-means clustering and the Kano model, are described, respectively.

4.1. K-means clustering

According to the mentioned points, the Kano analysis could be improved by the clustering technique. Therefore, after data processing, the K-means clustering was used according to the demographic variables. The questionnaire includes seven demographic variables, namely gender, nationality, age, education, hotel experience, the goal of the trip, and reservation way, presented in Table 4.

Table 30. Demographic features of the questioner

Gender	Nationality	Age	Reservation way	Experience in hotel	The trip goal	Educated or not
Male	Iranian	Young	Organization	Yes	Pilgrimage	Educated
Female	Arab	Not young	Telephone or coming Agency internet	No	Else	Not educated

The dataset analysis is done through a data mining tool called RapidMiner. This tool can easily handle numerical and categorical data together. The tool contains a different number of algorithms for performing clustering operations. In this article, the K-means operator in RapidMiner is used to generate a cluster model.

To process it through the K-means algorithm, attributes are converted into numerical values for the accuracy of results. Through RapidMiner, can be easily achieved using a nominal-to-numerical conversion operator (Anuranjana et al., 2019).

One of the clustering challenges is the number of clusters. There are various methods to determine the k numbers. In this study, the Silhouette method is used. According to this method, the closer the score is to one, the better k is selected. Therefore, as can be seen in Table 5, by using the Orange software, the Silhouette values from different clusters were calculated, and k=5 was chosen.

Table 31. Silhouette values for selecting clusters

Number of clusters	2	3	4	5	6
Silhouette value	0.29	0.28	0.28	0.32	0.31

In terms of the frequency distribution of the demographic variables in each cluster and experts' collaboration, they are labeled in Figure 3 as follows: Cluster 1: Housemen, Cluster 2: Co-men, Cluster 3: Housewives, Cluster 4: Tourists, and Cluster 5: Co-Women.
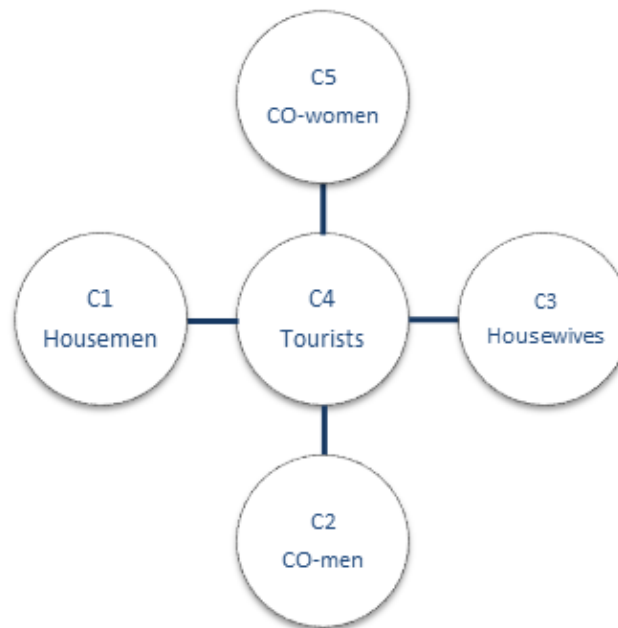
Figure 24. Five labeled clusters of the customers

4.2. The Kano analysis

In this section, the results of the Kano analysis related to customers' requirements are presented to make a more precise comparison between the results of the Kano model and the combined method. Table 6 illustrates the customer preferences. According to the Kano model analysis, the most frequent criterion is chosen as the most preferred one. For example, R7 gets a from the final category. According to Table 6, R8 and R15 are the requirements that should be avoided by the hotel manager. Also, R3, R11, and R13 should be strictly considered not to dissatisfy the customers. Number R5, i.e. providing the rental car, is the only indifferent requirement that customers do not care about; therefore, investing in this requirement might not be beneficial.

Table 32. Requirements analysis based on the Kano model

No.	Quality requirements	A	O	R	M	I	Final category
R1	Providing information about the exact time of services.	9.58	44.91	1.79	36.53	7.19	O
R2	Attractiveness of the equipment, etc.	13.02	52.07	0.59	22.48	11.84	O
R3	Cleanness of the hotel, equipment, etc.	4.14	43.20	0.00	48.52	4.14	M
R4	Sincere efforts of staff for solving guests' problems.	13.69	54.76	1.19	26.19	4.16	O
R5	Providing rental car service.	24.85	15.98	0.00	9.47	49.70	I
R6	Giving guidance book about the city.	38.32	19.76	0.60	14.37	26.94	A
R7	Providing transportation service from/to the airport/station.	34.32	26.63	0.59	16.56	21.90	A
R8	Requesting the tip	1.20	3.59	56.29	2.99	35.93	R
R9	Easy reservation.	15.98	44.97	0.00	26.03	13.02	O
R10	Quality and variety of foods and	7.69	47.93	1.18	34.91	8.29	O

R11	safe and secure accomodation in the hotel.	2.99	44.32	0.59	47.91	4.19	M
R12	Providing the Internet connection for guests.	35.12	22.03	0.00	19.05	23.81	A
R13	Providing various options of choosing rooms.	21.43	22.61	0.00	38.69	17.26	M
R14	Serving guests on the initial arrival date (welcome drinking).	28.15	33.53	1.79	23.35	13.18	O
R15	Waiting for a long time, when delivering the rooms.	3.57	11.91	70.83	7.15	6.54	R

4.2.1. The Kano analysis in clusters

The Kano analysis has been done again for each cluster. The results are shown in Table 7. Some requirements are discussed according to their clusters to gain a better insight. As shown in Table 4, the categories of R2, R4, R5, R8, and R15 are the same as the primary ones. Particularly R8 and R15, i.e., "requesting the tip" and "waiting for a long time when delivering the rooms," respectively, belong to the reverse category. It demonstrates that these two requirements annoy most people and should be considered entirely. Also, tourists are even indifferent to R5, i.e., "providing rental car service," but other requirements are not the same.

However, in other requirements, different preferences among the clusters are apparent. For example, If we look at R12, i.e., "providing the Internet connection for the guests," in Cluster 3, which is labeled as Housewives, there is an indifferent requirement. In contrast, it is considered a must-be requirement for tourists and an attractive one for other clusters, which seems reasonable. Therefore, some customers are stimulated by providing the Internet, and some others become dissatisfied when it is not provided.

Table 33. Category of requirements of the Kano model for each cluster

No.	C1	C2	C3	C4	C5	Primary category
R1	O	M	O	O	M	O
R2	O	O	O	O	O	O
R3	O	M	M	M	M	M
R4	O	O	O	O	O	O
R5	I	I	I	I	I	I
R6	A	A	I	A	A	A
R7	O	O	I	I	A	A
R8	R	R	R	R	R	R
R9	O	O	O	M	O	O
R10	O	O	O	M	M	O
R11	M	M	O	O	M	M
R12	A	A	I	M	A	A
R13	M	M	I	M	M	M
R14	O	O	O	M	M	O
R15	R	R	R	R	R	R

It is noticeable that all attractive requirements i.e., R6, R7, and R8 are indifferent to Cluster 3. This shows that these requirements are not crucial for the cluster, and the manager should seek other motivations for this group. R10, i.e., "quality and variety of foods and beverages," can be interesting for Cluster 4. It means tourists, who are mostly Arabic, think the food quality is a must-be requirement. This is the same for Cluster 5, either.

One of the exciting discoveries, found in the above table, is the number of M categories in each cluster. Cluster 4 (tourists) and Cluster 5 (co-women) have the most M categories, i.e., six out of fifteen Rs are M, but Clusters 2,3, and 1 have four, two, and one M, respectively. These points emphasize that Clusters 4 and 5 should be considered and behaved cautiously.

4.3. Prioritizing quality requirements in each category using the FAHP

The requirements of "must be" and "one-dimensional" categories must be met. If the hotel does not satisfy these requirements, it will lead to severe customer dissatisfaction. However, if the manager does not satisfy the requirements of the Attractive category, it will not lead to customer dissatisfaction. Therefore, in this phase, the FAHP is used to prioritize the quality requirements based on customers' preferences and their importance in the "Attractive category." Prioritizing and ranking the requirements in this category help the management group to improve their knowledge of investment preferences. Also, based on this prioritization, they can make critical financial decisions and future investments. According to the scores obtained from the Kano model, the Attractive category requirements include "Giving guidance book about the city (R6)," "Providing transportation services from/to the airport/station (R6)" and "Providing the Internet connection for the guests (R12)".

4.3.1. Ranking of the attractive category

By collecting experts' opinions, including hotel directors and assistants, pairwise comparisons have been made. Pairwise comparisons of triangular fuzzy number matrixes for the Attractive category are presented in Table 8. It should be noted that the inconsistency rate is less than 0.1.

Table 34. Pairwise comparison of triangle fuzzy number matrix for requirements

Attractive	R6	R7	R12
R6	(1,1,1)	(2,3,4)	(2,3,4)
R7	(0.25,0.333,0.5)	(1,1,1)	(0.5,1,1)
R12	(0.25,0.333,0.5)	(1,1,2)	(1,1,1)

Using Chang's method, S_i values are calculated for each row of the pairwise comparison matrix according to Equation 1. In the fifth column, the degree of preference is calculated based on

Equations 5 to 7. In the last step, using the weight normalization of vectors obtained from the degree of preference, the final weight is calculated and entered into the last column of Table 9.

Table 35. Ranks of requirements within Attractive category by using FAHP

Kano classes	No	Quality Requirement	S_i	Crips Value	Normalized Crips Value	Rank
Attractive	R6	Giving guidance book about the city	(0.043,0.058,0.106)	0.057	0.280	3
	R7	Providing transportation service from/to the airport/station.	(0.036,0.075,0.122)	0.068	0.334	2
	R12	Providing theInternet connection for the guests	(0.048,0.082,0.161)	0.078	0.384	1

The fulfillment of the Attractive category requirement leads to higher customer satisfaction. In contrast, its absence does not lead to customer dissatisfaction. This category includes three requirements, as mentioned above. With the increasing growth of virtual communications, the spread of virtual networks, and the Internet, the results of the requirements ranking through the FAHP method show that providing an in-room WiFi connection for guests (R12) is the most critical customer requirement with the highest value. Then, "Providing transportation service from/to the airport/station (R7) " and "giving guidance book about the city (R6) " are ranked in descending order of importance.

5. Conclusion

With increasing competition and rapidly changing customer requirements, organizations try to categorize, predict and prioritize customer preferences. Service quality in the hospitability industry is essential for managers. As a consequence, they try to get customers' voices and categorize them. It helps them to better understand what customers want and make decisions about financial and future investments based on the considered priority. In recent years, the Kano model has been used in several papers analyzing customers' requirements. These studies include He et al. (2015), Mattmann et al. (2016) but, most of them have often used qualitative analysis methods. In this article, by combining the Kano model and K-means, then FAHP, it is tried to improve the Kano model by analyzing the data and helping the top managers to better understand customers' requirements in a four-star hotel in Mashhad City. This combined method is used for the first time in the hotel industry. As mentioned earlier, customer satisfaction is considered one of the key goals of any organization. Satisfied customers are one of the success keys in any organization. In order to achieve organizational goals, customer satisfaction levels should be constantly improved. Therefore, the proposed method of the

present research can be used in service industries, such as banks and insurance organizations to measure customers' needs and obtain their satisfaction.

The results of this study show that the combination of the two mentioned methods creates the organizational ability to differentiate between customers. It allows the hotel managers to choose their target customers through understanding the requirements and type of them in each cluster; and, take the necessary steps to satisfy their target market needs. The findings of the research show that there are differences in the types of customers' requirements and their demands for each cluster using the Kano model. The attributes of "Attractiveness of the equipment, etc" (R2) and "sincere efforts of staffing for solving guest problems" (R4) for each of the five clusters are considered one-dimensional qualities. This means that the absence of the proper presentation of these requirements leads to customer dissatisfaction. In contrast, the full and proper presentation of these requirements leads to customer satisfaction.

Also, features of "requesting the Trip guidance" (R8) and "waiting for a long time when delivering the rooms" (R15) are Reverse qualities for all five clusters. In other words, if these features are presented, customers are dissatisfied, and customers are pleased if these features are not presented. Also,"providing rental car service" (R5) for all clusters is considered the indifference quality, meaning that customers do not care whether this feature exists or not. Therefore, the manager should ignore them. Staying safe and secure in the hotel (R11) is classified into the must-be categories in the first, second, and last clusters of hotel clients. Providing the Internet connection for the guests (R12) is classified into the attractive category in the first, second, and last clusters. This is not a perceived requirement by customers. As a result, the failure to satisfy this group of qualitative requirements does not result in customer dissatisfaction. However, offering them a product or service creates a great deal of customer excitement and satisfaction. The FAHP results also show that this requirement positioned in the attractive category has the highest priority. Therefore, if the hotel managers want to attract customers from the first, second, and fifth clusters, and to be more successful than competitors, they should have special attention to this variable.

As shown, by using clustering methods, decision-makers can better predict the requirements of each group or cluster. Thus, customers will be more satisfied because of delivering more customized services to each group. After classifying the requirements of each category, it is essential to focus on this issue due to the limited availability of resources, and prioritizing requirements in the Attractive category through the FAHP helps the management group to achieve more optimal outcomes.

In fact, by customer segmentation, hotel managers can identify the quality of customer needs using the Kano model and prioritize them in the attractive category to improve service quality.

This paper has some limitations. Firstly, we applied the proposed method only in one hotel with a sample of 168 customers. Therefore, It is recommended that future research be conducted with a larger sample size to be more generalizable. Secondly, Considering more experts other than hotel top managers can improve decision-making. Also, for future studies, integrating other data mining methods, such as Association rules, can discover more information. Comparing other clustering and classification tools would be appropriate, either. Moreover, multiple attribute decision-making methods can be used combined with the clustering method to select the most appropriate one for clustering. The results of the Kano and K-means compilation methods were analyzed to understand customer demands with the obtained priorities from the FAHP in this study. As a result, future studies can prioritize requirements in each cluster for a more accurate understanding of customer demands.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Designing a Dynamic Brand Equity Model Concentrating on Fake News in Coca-Cola Company

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A B S T R A C T

One of the most valuable assets for organizations is the brand of their products and services, as building a strong brand is critical to achieving competitive advantage and long-term survival in the marketplace. In this regard, it is necessary to constantly pay special attention to the status of the brand value compared to competitors to avoid the effects of fake news. Brand equity should be considered and investigated from different aspects because different factors, such as brand awareness, brand loyalty, brand association, perceived quality, and brand awareness, can affect brand equity over time. So, this concept is dynamic in marketing management. Therefore, in this research, using the system dynamics approach, a dynamic model is presented to investigate brand equity, focusing on fake news from the Coca-Cola Company, to understand better the marketing managers of the mechanism of brand equity changes over time.

The simulation outcomes demonstrated that the unique brand value and the factors influencing it do not change instantly but interact via feedback loops and build-up over time. The second stage's simulation findings revealed that fake news dissemination, brand equity, perceived quality, and brand awareness changed more than they did in the first. Customer loyalty is also influenced by perceived quality. The number of consumers who believe in the reputation and credibility of the company declines with the spread of fake information. Based on the outcomes of the simulation and the application of the policy of increasing customer knowledge, it was determined that the organization's investment to increase the customer's knowledge of the products and remove the misunderstandings brought on by fake information could increase trust in the brand and lead to the neutralization of the effect of fake news on the brand value and the factors affecting it.

1. Introduction

Fake news is now a topic of discussion in politics, everyday life, and the business sector (Flastrand et al., 2019). Fake news is being produced, broadcasted, and used more often than ever, costing businesses a fortune to stop it. Fake news has experienced two fundamental changes compared to the past: first, its scope has significantly grown; and second, the passionate communication circles that are produced by the transmission of fake news, which is both technologically facilitated by the Internet, encourage the spread of fake news (Berthon and Pitt, 2018). One of a company's most precious assets is its brand, and nowadays, building a strong brand that adds value to goods is a critical success element for many businesses (Nik Farjam and Abdulvand, 2015). Leading businesses and industry experts consider building brand equity to be a source of competitive advantage because it generates cash flow for the company, boosts brand loyalty, improves the effectiveness and efficiency of marketing initiatives, and lessens reliance on promotional costs, all of which lead to the creation of competitive advantages (Borkovsky et al., 2017). According to Berthon & Pitt (2018), fake news may be directly targeted at consumers or close to advertising algorithms, affecting brands and brand management.

As a consequence, fake news may harm some companies. Fake information on fake news about brands is disseminated by an unethical rival or a hostile fake news maker, which may enhance the buyer's perception of risk and reduce sales of an organization's goods (Flostrand et al., 2019). Brand managers create and improve a brand's value and image. Managers may develop methods to cope with fake news damaging consequences by looking at how it affects brand equity (Bronstein et al., 2019).

A thorough and systematic strategy is needed to examine fake news and its effects on brand equity and dimensions. However, only However, only a few studies have been done in this area, and they have yet to approach the problem systematically.. As a result, the systemic perspective of the present study may influence the knowledge and choices of product and marketing managers and provide light on the effect of fake news on the crucial variables that drive brand equity. The behavior of complicated and nonlinear systems may be investigated effectively using dynamic systems. Brand management comprises a complex system including delays, feedback, and nonlinear behaviors between various factors. Therefore, by using this tool, managers may broaden the mental model's bounds and limitations and foresee the results and ramifications of their actions before they occur. It is essential to provide a model to investigate the complex relationships between the key variables affected by the publication of fake news and predict the behavior of the variables over time. It will help managers protect their brand

with timely investments and appropriate measures, give the company a competitive advantage, and avoid losing customers and market share. Therefore, it is necessary to provide a model to investigate the complex relationships between the key variables affected by the publication of fake news and predict the behavior of the variables over time.

2. Literature review

Fake news is crucial for brands and their management, according to Berthon and Pitt (2018), for two reasons. First, companies may become targets of fake news, suffer direct harm, or distribute more fake news by utilizing the algorithm to position advertisements, i.e., by acting as fake news promoters (Mills et al., 2019). Using the brand equity model, Karroubi et al. (2017) concluded that the variables of brand loyalty, brand awareness, perceived quality, brand association, and brand image have a positive and significant effect on brand equity in their study titled "Evaluation of factors affecting brand equity among sportswear customers." The findings further demonstrated that brand loyalty had the most influence on brand equity, followed by brand image, perceived quality, brand association, and brand awareness, in that order. Their findings demonstrated that the elements mentioned above considerably affect consumers' attitudes about counterfeit goods and that consuming them significantly affects the brand value of genuine goods. The research titled "Online Consumers' opinion of brand fake news" was undertaken by Borges et al. (2020). The study's conclusions revealed that consumers' attitudes regarding fake news vary across European nations. Users who are young and tech-savvy are more likely to be able to spot fake news, and as a consequence, they are better equipped to assess digital news sources without the need for government involvement to lessen the effect of fake news.

The researchnamed "The Effect of fake news on the Attitude of social network users toward the Company" was undertaken by Bahadur (2020). The findings of his study show fake news had little effect on brand attitudes. People need to use their full cognitive ability while processing information online, which is one reason. Additionally, the findings showed that the gender of the customer affects the link above; hence, fake news only significantly affects brand perception among women. Further proof that exposure to fake news makes liberal customers dislike the news source is provided by Kwon and Barron (2020) "A World of Mistrust; Fake News, Distrust Mindsets, and Product Evaluations". They have less faith in the businesses offering the good or service, which negatively affects their opinion of that good or service. Together, these results show how fake news may affect liberal consumers' perceptions of all sources, leading to a "mindset of mistrust" that affects how they assess vendors' goods and

services. Fake news or actual false on marketing? The research title was done by Di Domenico et al. (2020). This research's overall finding is that the present methods are insufficiently capable of combating fake news. According to research by Tandoc et al. (2020), most Singaporean social media users dismiss fake news they see online. They only deal with fake news when it is pertinent to them and the individuals they have close relationships with. According to Flostrand et al. (2019), there is broad agreement that fake news is an increasingly common phenomenon and significantly affects brand management. Additionally, as service brands are more susceptible to fake news, brand management must be improved, or tactics to lessen fake news must be implemented. The study "Fake news identification in social networks using deep geometric learning" was done by Monti et al. (2019). It shows that one key characteristicthat make it possible to identify fake news accurately is how social networks are structured and distributed. In addition, fake news may be accurately identified in the first phases, even only a few hours after publishing. The modeling results give managers more understanding of publication-based methods for spotting fake news as complementary to content-based methods.

Pesonen's (2018) study revealed that customers need more confidence in social networking sites and other online businesses. Customers believed that digital giants like Facebook had a duty to combat fake news and that it was immoral for online businesses to collaborate with sites that spread it. Additionally, most consumers accept whether the news is real or untrue, which inspires mistrust. However, some customers attempt to check the news's accuracy, and even if it is wrong, they uphold their trust and encourage others. Ruiz-Meza et al. (2022) propose a System Dynamics model of destination brand equity to assess the evolution of the future behavior of related variables, including tourist arrivals. Zhang (2023) analyzes the growth mechanism of We-media brand equity from the perspective of the user's mind, applies the system dynamics method to carry out modeling and simulation analysis, and explores the general law of We-media brand equity growth. His paper finds that the external environment and similar We-media have no obvious effect on the growth of We-media brand equity. However, brand communication will have a direct positive effect.

So far, many types of research have been conducted in the field of brand equity and the impact of fake news, but most of them, such as Pesonen (2018), Bahadur (2020), Borges et al. (2020), are statistical or like the study of Monti et al. (2019) are qualitative. However, different variables affect the extraordinary value of the brand, and the effect of some variables is determined over time, so it is a complex system.. The use of statistical methods cannot thoroughly investigate and analyze the characteristics of this complex system. Therefore, in this research, the system

dynamics method has been used. A review of the research background shows that limited studies such as Crescitelli and Figueiredo (2009), Jing-Bo et al. (2017), and Zhang (2023) have been done in the field of a brand with the method of system dynamics. However, these studies have not investigated the effect of fake news on brand equity. Therefore, the current research is innovative in this sense.

3. Research method

Due to its goal of demonstrating the feedback effects of fake news on brand equity and its variables in the Coca-Cola Company, the present study is classified as applied research. The findings of this study may influence the knowledge and choices made by product and marketing managers and provide light on how fake news affects important brand equity-determining elements. The present study is quasi-experimental because the researcher employs simulation to test several policy options without interfering with the studied condition. The Coca-Cola Company is the focus of this investigation. Additionally, this study is grounded on mixed data, which refers to studies combining quantitative and qualitative research approaches (Mobini Dehkordi, 2012). This issue is brought on by the research's unique methodology, namely the systems dynamics approach. Models of system dynamics are under the umbrella of mathematical causal models. The research is qualitative in the phases of understanding the system, understanding the research topic, and developing the model based on the dynamic assumptions gained through the study of statistics, literature review, and expert interviews. The quantitative portion of the study includes creating the model in "Vensim" software, defining the model, and assessing the findings.

3.1. Dynamic hypothesis

When the value of the brand equity had increased, the price of the products will also increase. Therefore, with a price increase, the perceived quality increases, which leads to an increase in brand equity value (Hidayatno et al., 2013). Nevertheless, the price increase from another direction leads to a decrease in customer retention, and as a result, sales and profitability decrease. With the decrease in profitability, the competitive advantage and, as a result, the particular value of the brand equity decreases (Figure 1). In this research, the effect of fake news on brand equity has been investigated. Fake news, as an exogenous variable, indirectly affects brand equity by negatively affecting perceived quality and trust in the brand and leads to its decrease over time (Pesonen, 2018).
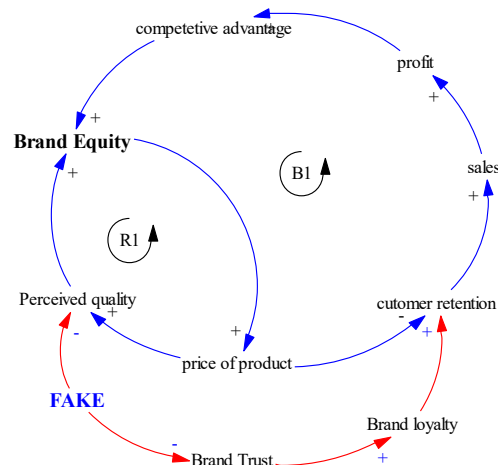
Figure 25. Dynamic research hypothesis

3.2. Model assumptions

To decrease the complexity of the model and make modeling possible, the following assumptions are regarded in the model of this study.

Due to simplify the model and facilitate modeling, the following assumptions were considered in this study's model:

(9) Only the effect of negative fake news on brand equity was examined during the planning horizon, while the effect of positive fake news was excluded due to insufficient information.

(10) The simulation in this study covers a period of 60 months (from 2020 to 2025), equivalent to 5 years.

(11) Qualitative variables such as brand experience and uniqueness were excluded from the model due to their subjective nature and the challenges involved in quantification.

(12) The variable of mental involvement was omitted from the model due to limited information. It depends on external factors such as location, product, and communication, as well as internal factors such as individual pronouns and core values.

(13) In this study's model, the role of competitors in shaping the brand's unique value is considered solely in terms of their investment in customer communication and the presence of other commercial brands in customers' purchasing decisions.

3.3. Causal loop diagram

The system dynamics method typically involves conducting interviews with experts to develop causal and circular diagrams and flow diagrams. This study initially constructed a causal and circular model around brand equity, incorporating findings from various background research. Subsequently, the model was refined and finalized through experts' opinions and adjustments.

The causal relationships in the model are referenced in Table 1. These relationships were initially identified based on the background research and subsequently refined, adjusted, and completed through the opinions provided by the expert team.

Table 36. The reference of causal relationships in the causal and circular model of the current research

Relationships	Sign	Author
Investing in public relations → brand awareness	+	Otto & Bois (2001)
Word of mouth advertising → brand awareness	+	Crescitelli and Figueiredo (2009); Maria et al (2019)
Customer Loyalty, Perceived quality → Brand equity	+	Ebrahim (2020); Otto & Bois (2001)
Efficiency and effectiveness of marketing programs → investing in advertising	−	Karroubi et al (2017); Datta et al (2017)
Fake news → brand trust	_	Pesonen (2018); Berthon et al (2018)
Brand equity → Customer retention	+	Stahl et al (2012)
Perceived quality → Customer Satisfaction	+	Hidayatno et al (2013)
Brand awareness, brand association → Brand equity	+	Hidayatno et al (2013); Azzari and Pelissari (2021)
Price product→ perceived quality	+	Keller (2003); Iranzadeh et al (2012)
Price product→ customer retention	-	Baldauf et al (2009); Iranzadeh et al (2012)
Customer retention→ competitive advantage	+	Baldauf et al (2009); Yoo et al (2000)
Brand association → Perceived quality	+	Yoo et al (2000); Kim (2010)
Relationship quality→ Brand loyalty	+	Chattopadhyay et al. (2010)

The causal loop model was constructed by integrating the research background and incorporating the opinions of the expert team. This model encompasses numerous variables, feedback relationships, and the resulting causal loop diagram, labeled Figure 1. The loops within the diagram are explained below in sequential order. The final brand equity causal loop diagram can be found in Figure 2.

R1: Customer satisfaction and brand trust rise as perceived quality rises. Due to word-of-mouth marketing, devoted consumers also boost perceived quality and brand loyalty. Additionally, the exogenous variable of fake news has a detrimental and diminishing effect on perceived.

B1: As the price of a brand's goods rises in response to increased brand value, customer retention suffers, which lowers sales and profits and, ultimately, the brand's competitive advantage.

R2: Product prices rise due to rising marketing expenses brought on by a decline in brand value. As a result, it becomes challenging to attract and keep consumers, and as sales, profitability, and competitive advantage all decline, so does the brand's unique value.

R4: As brand value rises, so do consumer attractiveness, sales volume, profitability, and competitive advantage—all to a more significant degree than previously. Consequently, the brand's worth rises as well.

B2: The organization's overall investment level declines as brand equity rises. Consequently, less money is spent on public relations, and customer communication is of lower quality than before, which lowers customer loyalty. Customer retention suffers as a consequence, which reduces the brand's competitive edge and, eventually, its unique value.

B3: Marketing expenses rise as brand equity declines. The product's cost may also rise due to this procedure. The buyer associates more outstanding quality with a more expensive product. Therefore, improving perceived quality may result in an improvement in brand value.

R3: As brand value has improved, customer retention has increased, which results in the desire to repurchase. This process creates pressure from consumers to raise quality, which over time compels businesses to increase their expenditure in R&D. As a result, brand equity and perceived quality also grow with time.

B4: Marketing efforts become more efficient and successful as brand equity rises. Therefore, corporations tend to make fewer investments to save expenses. As a result, less money is spent on point-of-sale and sales marketing. It has a detrimental and diminishing effect on brand association, perceived quality, and brand awareness, which eventually causes a decrease in brand equity. The final causal loop diagram of this study is depicted in Figure 2.
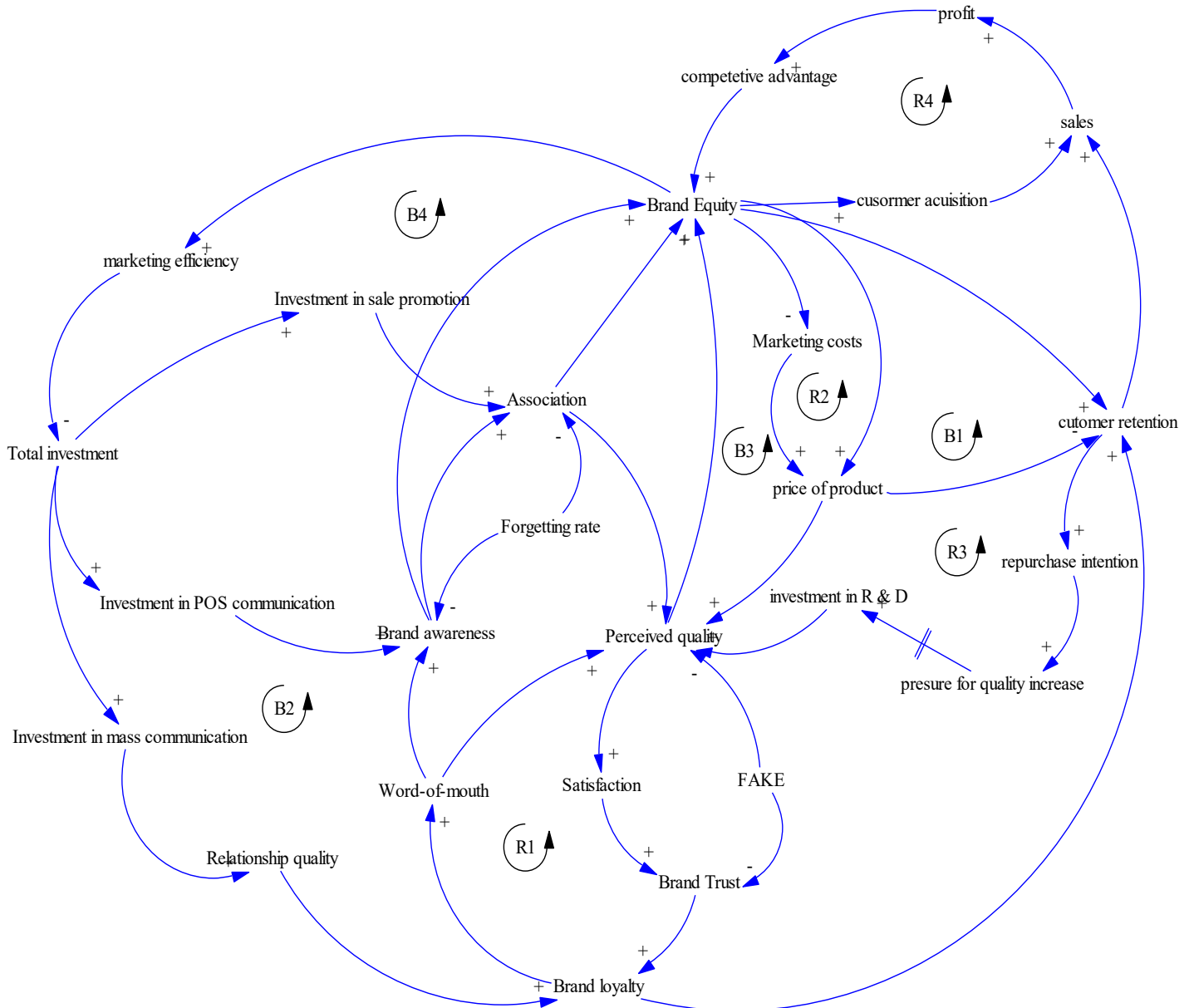

Figure 26. Final causal loop diagram of this study

3.4. Stock and flow model

Considering a kind of division of variables in the Stock and flow model of dynamic systems in this study, these variables are as follows. Table 2 indicates the types of variables applied in this study.

Table 37. Introducing the type of research variables

Row	Variable name	Variable type
1	Brand equity, brand association, brand awareness, perceived quality, brand loyalty.	level
2	The decrease and increase rate of brand equity, the decrease and increase rate of brand association, the decrease and increase rate of brand awareness, the decrease and increase rate of brand loyalty, and the decrease and increase rate of perceived quality.	Rate
3	Forgetting rate, percentage of investment in direct communication, percentage of investment in media advertising, percentage of investment in point of sale.	Fixed
4	Efficiency and effectiveness of marketing activities, total investment, product price, quality of communication, competitive advantage, profit, sales, word of mouth advertising, customer satisfaction, investment in direct communication, brand trust, investment in research and development, customer pressure to increase product quality, repurchase intention, customer retention, customer acquisition, marketing costs, competitors' investment in communication, availability of other competitors' products.	Auxiliary

In this part, the stock and flow diagram of the model is drawn due to the causal loop diagram described in the previous section. The stock and flow model drawn in Figure 3 shows how various factors affect brand equity.
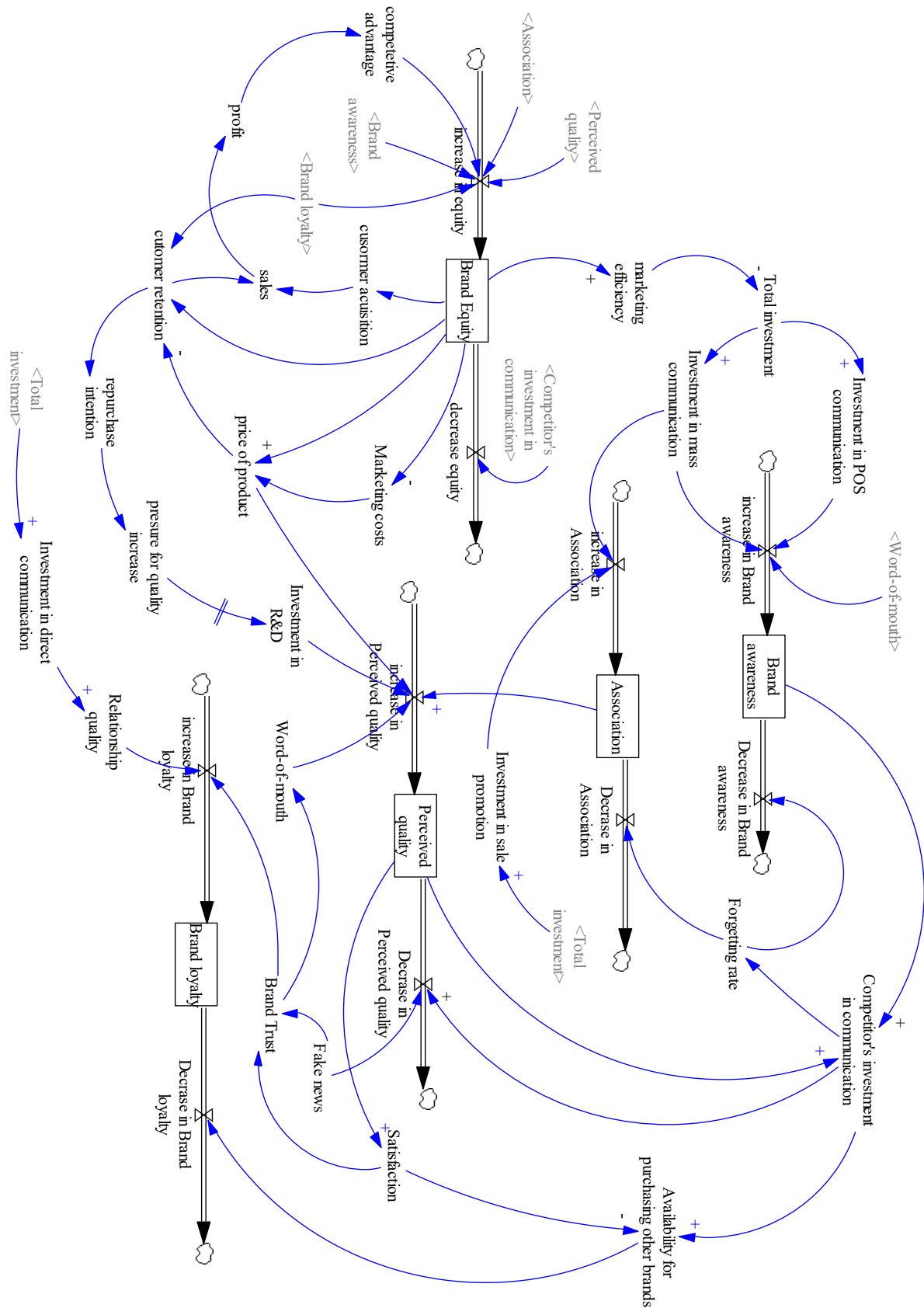
Figure 27. A comprehensive of stock and flow diagram of components affecting the brand value

3.5. Formulating stock and flow model

3.5.1. Endogenous (dependent) variables in the model

*Brand equit*y: It is a factor that builds over time. The value of this variable in 2020, as determined by the papers that are readily accessible, was equal to 84 billion dollars, which is considered the beginning value at the time of the simulation. Its input rate is the sum of the primary determinants of brand value (including dimensions of brand awareness, brand association, perceived quality, and brand loyalty). This variable (competitors' activity and investment in communication) is considered an output rate; throughout time, the quantity of this variable is defined by changes in the elements affecting the brand's unique value. It is also important to note that the brand's unique value rises as the competitive advantage doesIt is important to note that Acker's (1993) brand equity framework was used to describe this process in stock and flow modeling. Equations 1, 2, and 3, compute brand equity variables, gain, and drop rate.

Brand Equity= INTEG (increase in brand equity- decrease in brand equity, 8.4)	(1)
Increase in brand equity= Brand Association+ Brand awareness+ Brand loyalty+ Perceived quality of brand+ competitive advantage	(2)
Decrease in brand equity= Competitor's investment in communication*0.59	(3)

Research and development spending: This variable serves as an auxiliary variable. This approach assumes that increasing brand value increases client retention and their likelihood of making another purchase. Customers now have higher expectations for quality. Thus to enhance quality, the company must engage in research and development. This auxiliary variable has been explained using the delay function (Delay) since it varies over time and with a delay. Equation 4 is based on a concept from study of Ishii (2014).

Investment in R & D= DELAY1 (pressure for quality increase, 24)	(4)

Brand awareness: This accumulation-type variable is taken into account at three different input rates. The quantity of word-of-mouth advertising, point-of-sale investment, and mass communication investment all contribute to an increase in this variable. On the other hand, the forgetting rate, which is influenced by rivals' actions, successfully lowers this variable over time. Equation 5 is used to get the value of this stock variable from the integral of the difference between the total sources of increasing and decreasing brand awareness. Equations 6 and 7 are also used to calculate the variable input and output rates, respectively. The paper by Shafeiha et al. (2016) has been cited for elaborating on this concept and providing the necessary equations.

Brand awareness= INTEG (increase in brand awareness rate- decrease in brand awareness rate, 7.69) (5)

Increase in brand awareness rate =Investment in POS communication+ Investment in mass communication) + Word-of-mouth (6)

Decrease in Brand awareness rate= forgetting rate (7)

Brand association: This variable is regarded as a state variable in the stock and flow model. This study assumes that spending on direct marketing and sales promotions would affect brand association growth. On the other hand, the forgetting rate, which is influenced by rivals' actions, successfully lowers this variable over time. Using Equations 8-4, the value of this variable is determined by taking the integral of the difference between all causes of rising and decreasing brand association. Additionally, Equations 9 to 11 have been used to calculate the variables of input and output rates and the variable of forgetting rate depending on the activity and investment of rivals, respectively. The formulae listed here were taken from a scientific literature survey, mainly from works by Hidayatnoa et al. (2013) and Cristelli and Figueidoro (2009).

Brand association = INTEG (increase rate in brand association- Decrease rate in brand association, 7.9) (8)

Increase rate in brand association= Investment in mass communication+ Investment in sale promotion (9)

Decrease rate in brand association= Forgetting rate (10)

Forgetting rate = 0.1*Competitor's investment in communication (11)

Marketing costs: This auxiliary variable, which quantifies the number of marketing expenses, is anticipated that the quantity of marketing expenses would drop as brand equity increases, according to an interview with marketing managers and a study of research literature. Because the smooth function is often used to calculate time averages and display expectations, it is utilized to get the value of this variable. While designing this function, it was thought that after 14 months, marketing costs would fluctuate and be anticipated to reduce whenever the brand's worth increased. Equation 12 depicts the effect of the brand equity variable's relationship to marketing expenses.

Marketing costs= SMOOTH (1/Brand Equity, 14) (12)

Product price: Marketing expenses and brand equity presumptively influence this auxiliary variable in this study. In this model, it is presumable that brand equity has an 80% effect on product price and that marketing expenses have a 10% effect. The examination of unofficial materials like websites and experts' views have been utilized to determine this variable's value. This variable may be calculated using Equation 13.

Price of product= 0.8*Brand Equity+0.1*Marketing costs   (13)

Fake news: In the model execution mode for the current circumstance, this variable is regarded as an exogenous variable (Base Run). (Based on the STEP function, this variable has been added to the system to emulate it. Equation 14 displays the creation and dissemination of fake information throughout 24-28 and 38-41 months. This formula illustrates how the amount of fake news published doubled over the simulated period. The policy part of the next chapter has further details. Ideas from works by Burton and Pitt (2018) and Pesonen (2018) were used to create in Equation 14.

Fake news= STEP (-1, 24) +STEP (1, 28) + STEP (-2, 38) + STEP (2, 41)   (14)

3.5.2. Exogenous (independent) variables in the model

The following values for the variables in the model have been obtained from information from informal sources such as websites and oral information from experts and marketing managers in the food industry and the Coca-Cola brand in Mashhad. The results are shown in Table 3.

Table 38. Exogenous variables of the model

| Variable name	Value
Percentage of investment in direct communication	30%
Investment percentage in media advertising	30%
The effect of brand equity on product pricing	80%
Investment percentage at the point of sale	30%
Forgetting rate	10%
The effect of increasing customers' access to other competitors' products on reducing loyalty to the company's product	30%

4. Validation of the designed model

4.1. Structural validation of the dynamic model

There are several tests to verify the dynamic model in terms of structure and behavior. Vensim software is used as one of the structural validation techniques for the dynamic model. The accuracy of the performed model can be checked by pressing CTRL+T. The model's structure includes rate and state variables. The equations utilized are compatible, and the model is structurally authorized and appropriately applied according to the message provided by the expressive software.

4.2. Behavior reproduction test

To verify the correctness of the model's behavior, this test will compare the simulation results with actual data. The figures' findings demonstrate how well the researched variable may be replicated. The results are shown in Figure 4.
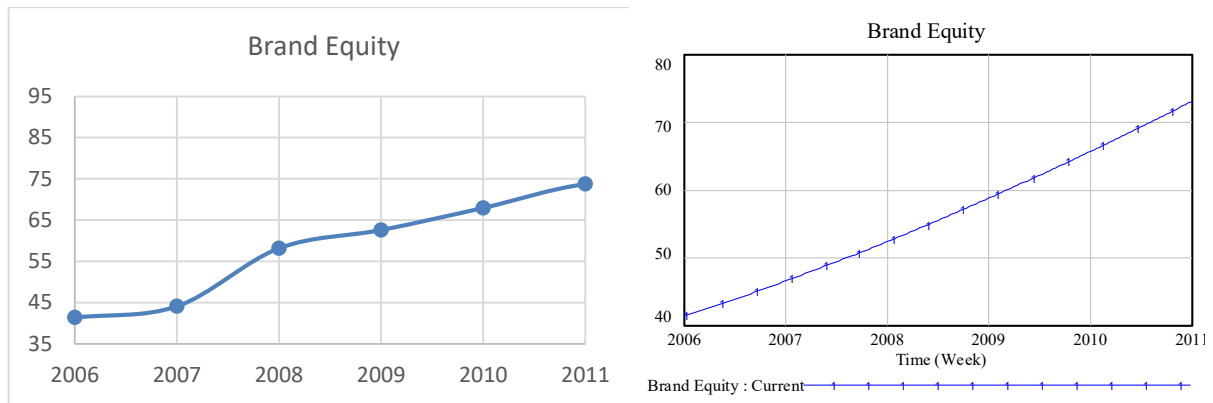
Source: www.statista.com (Coca-Cola's brand value)   Source: Research results

Figure 28. Comparison test with reference behavior

4.3. Behavioral validation

4.3.1. Examining the model's capability under extreme conditions

Extreme condition test is conducted to see if the model operates realistically under extreme conditions. In this test, the extremely high and shallow values of the model's primary variables are investigated for behavior, and the model's sensitivity to these changes is examined. This test compares the produced behavior to the expected behavior by assigning limit values to the model's chosen parameters.

For this test, it is assumed that the variable brand awareness decline rate—caused by rivals' actions and forgetting rate—has instantly achieved zero. It follows that a rise in the brand awareness stock variable is anticipated. The model's behavior is contrasted with the base state in Figure 5 (a), and the test's behavior is consistent with expectation. The outcome of this test and the state variable's non-negativeness provide evidence that the model structure results in acceptable behavior under extreme conditions.

Since it is assumed in this test that the variable measuring the perceived quality loss rate would be zero, it is anticipated that the perceived quality will increase somewhat. The behavior from this test aligned with what had been anticipated, and Figure 5 (b) compares the model's behavior to the initial state. The outcome of this test demonstrates that, according to experimental and theoretical data, the model structure generates appropriate behavior under extreme conditions.
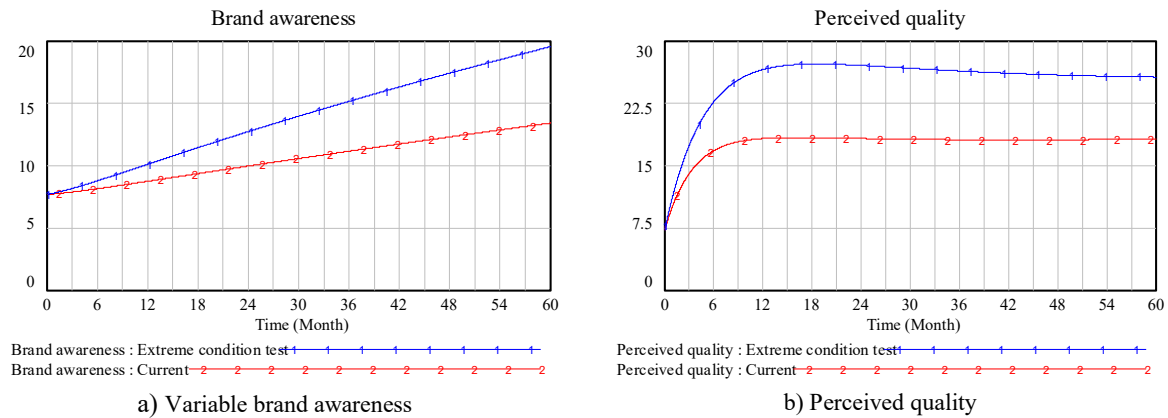
a) Variable brand awareness   b) Perceived quality

Figure 29. Extreme condition test

4.3.2. Sensitivity analysis

This test serves as another method to validate the behavior of the model. It addresses the question of whether the model's conclusion can still hold even in the absence of precise parameter values. This test demonstrates that the system does not respond significantly to changes in parameter values, which lowers the modeler's uncertainty level on the variables' behavior. It is hard to conduct a thorough sensitivity analysis since it would entail testing all conceivable combinations of assumptions about the variables' uncertainty range due to the examined model's complexity and the abundance of variables. The developed model's validity was tested for this aim by altering various parameters. In Table 4, this sensitivity analysis is shown.

Table 39. Validation of the designed model by sensitivity analysis

Cause		Intermediate variables	Disabled		
Variable	**Action**		**Variable**	**Waiting for the researcher**	**Result**
Brand equity	Increase	price of products	Customer retention	Decrease	Decrease
Customer satisfaction	Decrease	Brand trust activities	Brand loyalty	Decrease	Decrease
Brand trust	Decrease	No interface variables	loyalty	Decrease	Decrease
Sale	Increase	Profit	Competitive Advantage	Increase	Increase
Brand equity	Increase	The effectiveness and efficiency of marketing	The amount of investment in advertising	Decrease	Decrease
Brand awareness	Increase	Brand associations	Perceived quality	Increase	Increase

For instance, brand loyalty also declines in proportion to a decline in brand trust. Additionally, due to the favorable effect that rising sales have on an organization's profitability, its competitive edge also grows. On the other side, growth in brand value may result in higher

product prices, which makes it harder to keep consumers and may even result in a customer decline.

Interviews should be utilized as an effective technique to validate the model based on the opinions of experts and current management, and it should be mentioned. For this aim, marketing managers and specialists in the food sector examined and approved the causal loop diagram, stock and flow diagrams, and behaviors generated by the models. They thought the model's structure accurately reflected natural processes, and its predictions accurately captured the system's actual behavior.

5. Simulation results

The model has produced the following results as a consequence of the behavior of the key factors and key indicators in the brand's unique value by the relationships between the model's variables that were indicated.

5.1. Implementation and evaluation of policies

This part introduces the implementation policies and the analysis of each one.

5.1.1. The policy of the status quo

One of the most valuable subjects in brand management and branding is the brand's unique value, which is the primary variable in this study. Figure 6 shows this variable's state over a 60-month (from 2020 to 2025). The marketing division specialists and managers claim that this graph's behavior is precisely in line with how this variable evolves and how it is right now. Equity in a brand is increased over time through positive developments. In other words, there has to be much work done to raise other important variables like brand recognition, brand loyalty, perceived quality, and brand connection to enhance this variable.
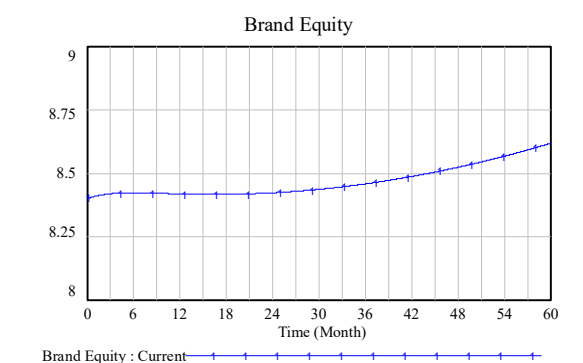

Figure 30. The amount of equity of the existing brand

5.1.2. The policy of surveying the effect of fake news on brand equity and the factors affecting it

Reviewing the study literature revealed that the publication and spread of fake information harm consumers' perceptions of the brand's reliability and trust. Over time, due to feedback loops, the brand equity variable also changes. This strategy assumes that fake news will appear twice during 24–28 and 38–41 throughout five years. Exogenous fake news is used in this changeable policy, harming the brand's perceived quality and consumer confidence. The evolution of brand equity throughout the experiment is seen in Figure 7. Indeed, it is evident that the brand equity value initially experienced a decline over four months, with a gradual slope. Subsequently, it rises over the same duration, again with a gradual slope. This example demonstrates the distinct value that a great brand has in the eyes of the consumer. Although the dissemination of fake news initially skews consumer perceptions, brand recognition will eventually rise if marketing and investment efforts are sustained. The effect of posting fake news a second time is what matters in the diagram given. The diagram's behavior demonstrates that brand equity declines more rapidly and substantially in the second order. Because of this, if marketing managers do not address the issue and stop the spread of similar news, the brand's unique value will gradually decrease.
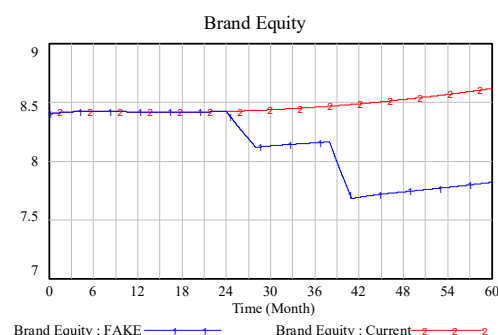

Figure 31. The special value of the brand after the publication and spread of fake news

In that order, the behaviors of brand awareness, brand association, brand loyalty, and perceived quality variables are shown in Figure 8. Customers' perceptions of quality have declined significantly after the distribution of fake information, particularly in the second neighborhood. It is because, within a short period following the dissemination of fake news, consumer perceptions of quality are more immediately affected. It should be mentioned that the Coca-Cola brand's perceived quality has stabilized over time due to the brand's maturity stage of its life cycle. Because of this, even word-of-mouth marketing, proper pricing, and better distribution accessibility do not affect perceived quality. The feedback loops connected to brand trust, word-of-mouth marketing, and organization marketing actions affect brand awareness

most among the previously stated elements. Compared to the baseline, brand loyalty likewise declined; nevertheless, the brand association variable has marginally altered. These actions indicate that, in contrast to any assault by fake news, mature brand loyalty and association are quite robust.

a) Brand awareness

b) *Perceived quality*

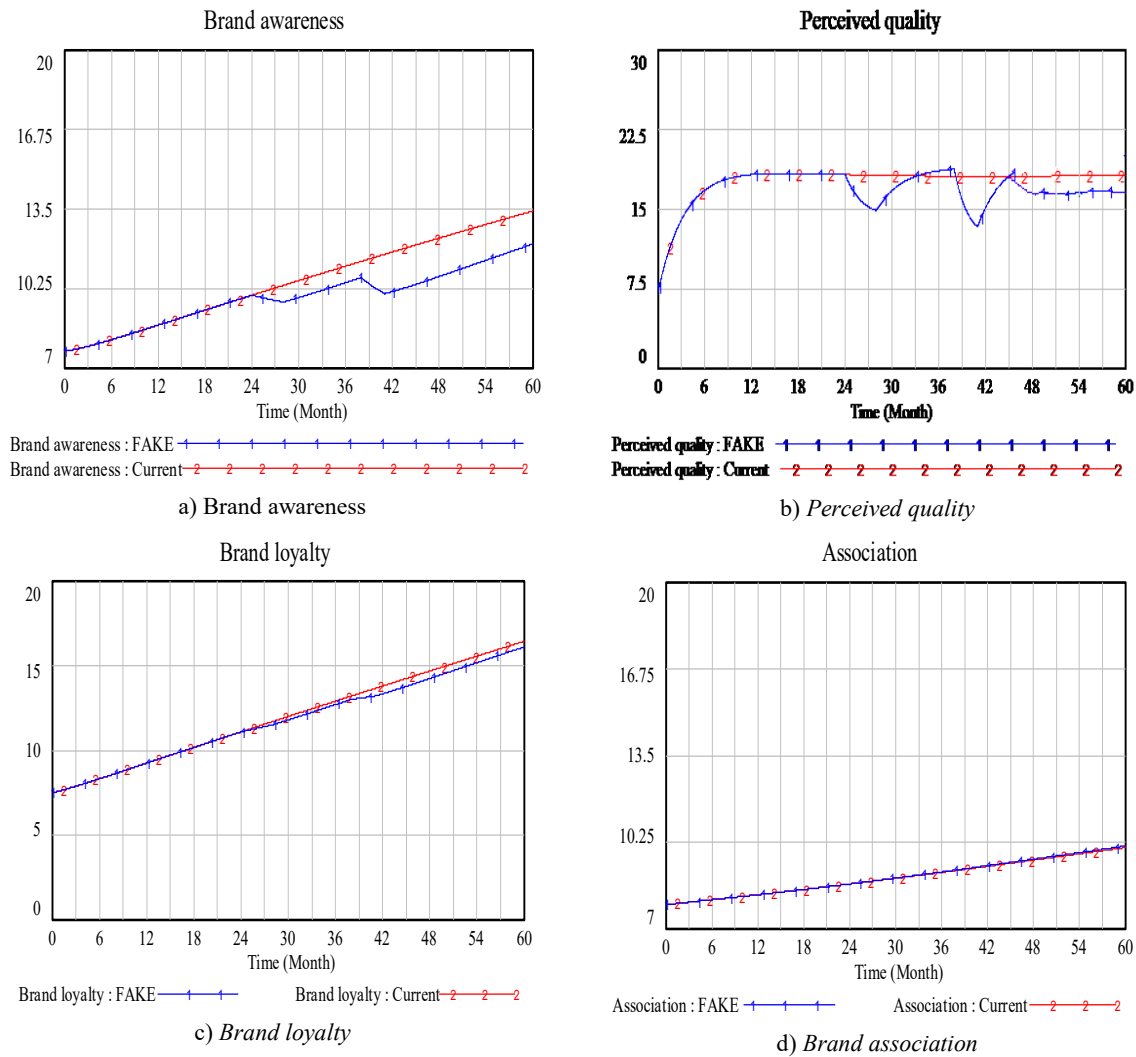c) *Brand loyalty*

d) *Brand association*

Figure 32. Results of policy influence of fake news on brand awareness, perceived quality, brand loyalty, and brand association

Figure 9 illustrates the investments in point of sale, sales marketing, and public relations. In the long run, as equilibrium loops exist, the behavior of the diagrams reaches a state of equilibrium. When fake news is released, companies are compelled to increase their investments in advertising to mitigate the potential decrease in their brand equity value.

a) *Sales promotion investment*

b) *Investing in advertising at the point of sale*
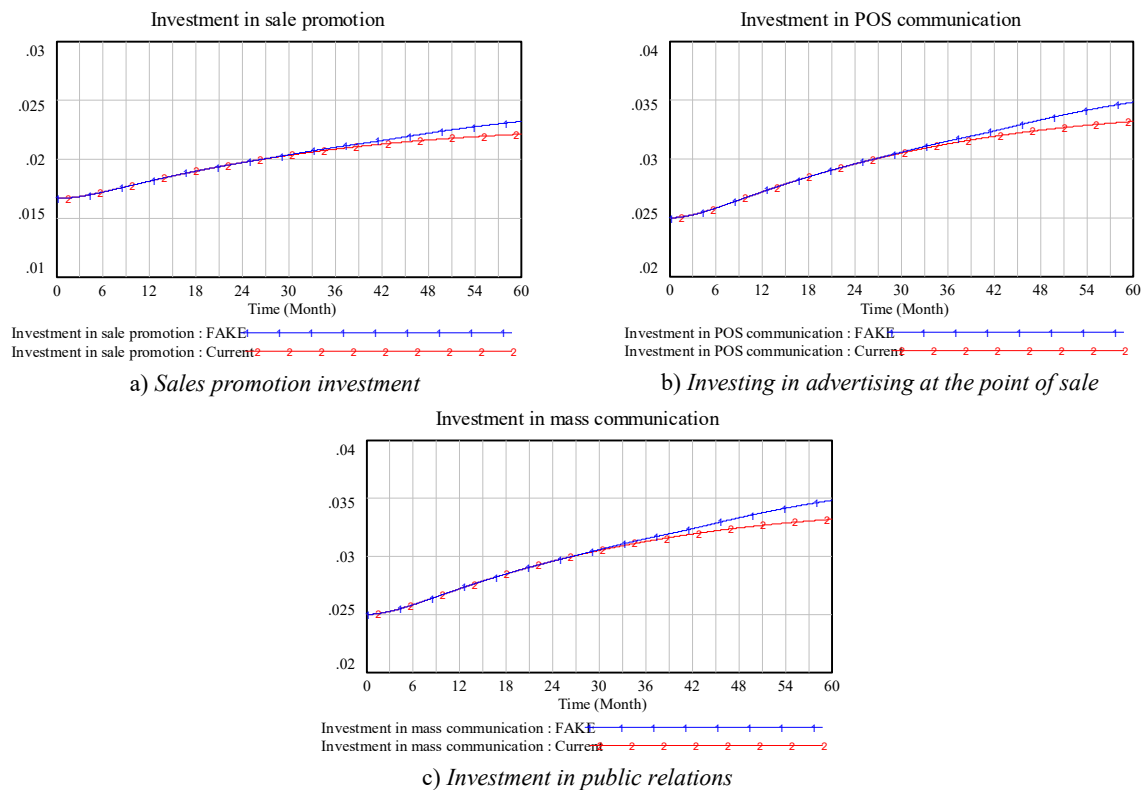
c) *Investment in public relations*

Figure 33. Results of policy influence of fake news on sales promotion investment, investing in advertising at the point of sale, and investment in public relations

5.1.3. The policy of Increasing customer knowledge

The ability to comprehend and connect with consumers' preferences, behaviors, and expectations plays a significant role in shaping the brand's unique value and effectively engaging with the target audience in the digital realm of social media. Indeed, the understanding of consumers is another crucial aspect of a brand's unique value, especially in social media. Depending on client demands, employees may exchange information using tools, methods, and contexts provided by knowledge management (Wang et al., 2017). Knowledge is seen as a business's competitive advantage, particularly in the modern period when the extensive use of information technology serves as a marketing signal. By raising the level of knowledge, a company can also raise the level of the quality of its services by gathering knowledge about its customers (from the perspective of the organization) and, at the same time, the quality of the relationship between the customer and the company also improves as a result of the knowledge acquisition. (Round and Roper, 2012); Therefore, increasing brand equity depends greatly on consumer understanding.

Fake news is regarded as an endogenous variable in this strategy, and its effects on brand equity are examined by including the variable of growing consumer awareness in the model. This policy assumes that the firm would dedicate part of its expenditures to improving customer

knowledge. Figure 10 depicts the evolution of consumer understanding. The atmosphere focuses on this variable's behavior, eventually reaching its peak degree. When customers are well-informed, they tend to respond less to fake news. The effect of this variable on brand equity and the variables affecting it is shown in charts Figure 10.
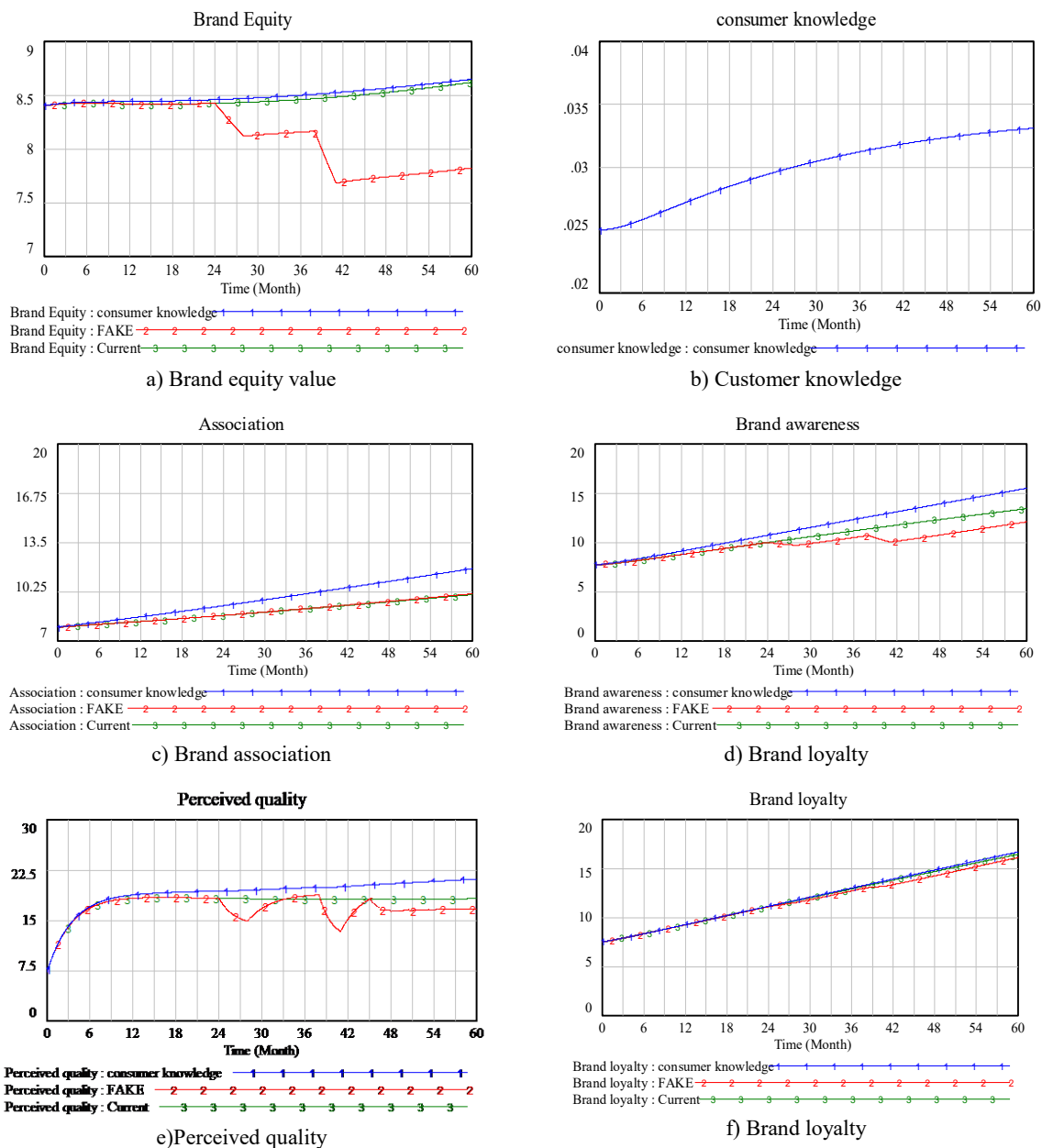

Figure 34. Results of key variables after applying the policy of increasing customer knowledge

The behavior the diagrams behave implies that when brand trust rises along with consumer understanding, the effect of fake news diminishes. As a result, brand equity, brand recognition, brand association, brand loyalty, and perceived quality. Due to Coca-Cola's status as a mature brand with limited significant competitors in the industry, brand loyalty has less growth than the previously described factors. Owing to the change in consumer awareness, the brand

association variable may be more sensitive to fake news than it was under the prior strategy. As a result, the brand's perceived quality may be higher than it was at the baseline.

6.   Discussion and conclusion

Today, brands serve as the key capital for many organizations since they serve to present the product and highlight its unique qualities. Although brand equity has received much attention in previous studies, the effect of fake news on this measure and the factors that influence it has not been thoroughly and consistently investigated. Therefore, using the system dynamics technique, this study has attempted to model the consequences of fake news on the brand's unique value and how to enhance it by creating policies. The simulation findings from this study may broaden marketing managers' perspectives and aid them in making choices that will enhance brand value. Because in the spicy food industry, this long-term consumption period is considered, the model described in this study was simulated for 5 years (Hedaytno et al., 2013). The simulation's findings demonstrated that the brand's unique value and affecting factors interact via feedback loops and build up over time. These results are consistent with the results of the studies of Shafeiha et al. (2016) and Aker (1993).The findings of this study suggest that spreading fake news about the organization and its goods often may eventually lessen the brand's unique worth. The simulation's findings demonstrated that brand equity, perceived quality, and brand awareness characteristics changed more in the second stage of fake news broadcasting than in the first. Customer loyalty is also influenced by perceived quality. The amount of consumers who believe in the reputation and credibility of the company declines with the spread of fake information. Large companies like Coca-Cola are thus compelled to boost expenditure in advertising and sales promotion, even though it may be challenging to penetrate a brand that has attained high recognition. These findings are consistent with Pesonen's (2018) and Ebrahim's study (2020). Based on the outcomes of the simulation and the application of the policy of increasing customer knowledge, it was determined that the organization's investment to increase the customer's knowledge of the products and remove the misunderstandings brought on by fake news could increase trust in the brand and lead to the neutralization of the effect of fake information on the brand equity and components affecting it. By investing a small amount of money in applying this strategy, the company can strengthen the bond between its brand and its consumers by reducing dangers like a drop in the brand's perceived quality and unique value. This result agrees with Berthon & Pitt (2018) and (Iglesias et al., 2017).

Marketing executives need to stop the dissemination of fake news. They may use deep learning artificial intelligence tools to detect suspect information or pay professionals to work on repairing and neutralizing it. They may do this by using modern techniques to restrict sites that disseminate fake news and by identifying and attempting to correct the weak places in their brand. By enhancing consumer communication, The Coca-Cola Company may utilize them to spot fake news, fake content, and associated websites. For instance, Coca-Cola brand fans may sign up on internet forums to notify managers and brand owners if they come across any commercials with questionable material. The business may also consider offering gifts and discounts on future purchases to entice more consumers to join. In certain of its advertising and marketing initiatives, the Coca-Cola brand may inform customers about online fraud and algorithmic targeting practices employed by marketers. In this approach, raising consumer knowledge may shield a brand's reputation from the damaging effects of fake news. The simulation findings of the current research demonstrated that the brand's unique value is dynamic and that all the factors and dimensions that affect it may vary over time depending on various policies. Therefore, marketing managers should carefully consider the brand's unique value in long-term and short-term strategies and concentrate on raising it via feedback linkages between the factors that affect it. By considering other contributing factors, researchers may use different strategies to defend against the damaging effects of fake news and utilize the model given in this study as a foundation for brand equity management. Future studies will be able to evaluate and contrast the hazards posed by fake news with other challenges to brand management by expanding the model that has been given. Future studies might assess the effects of fake news on the brand equity of particular categories of commercial brands that are more susceptible than others using the approach described in this study. Additionally, this methodology may be modified to assess the brand's unique value in various sectors. In order to maintain brand equity and promote it, considering other influencing elements like competitor activities and the significance of social networks in future research, it is required to apply the system dynamics method.

Disclosure statement

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