



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

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ABSTRACT

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 organization'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.

Keywords

Systems thinking, Fuzzy Delphi, Thinking styles, Evaluation model, Excellence levels of organizational systems thinking.

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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 (Loqhma 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 1. 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.

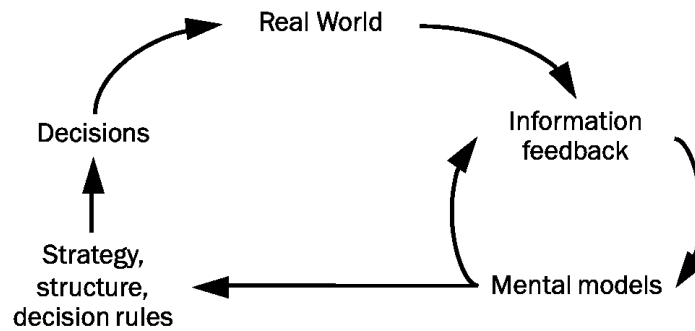


Figure 1. The double-loop learning model proposed in systems thinking (Sterman, 2000)

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.

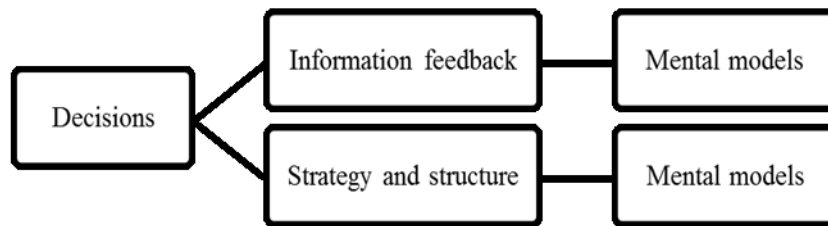


Figure 2. The role of the mental models in the double-loop learning model

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.

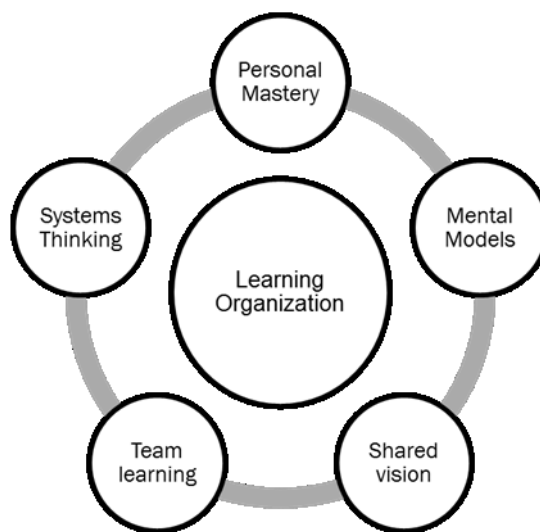


Figure 3. The role of the mental model in a learning organization (Senge, 1990)

Considering the factors of mental models, including values, beliefs, assumptions, and the process of thinking and reasoning (Stermann, 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's analytical model is presented in Figure 4.

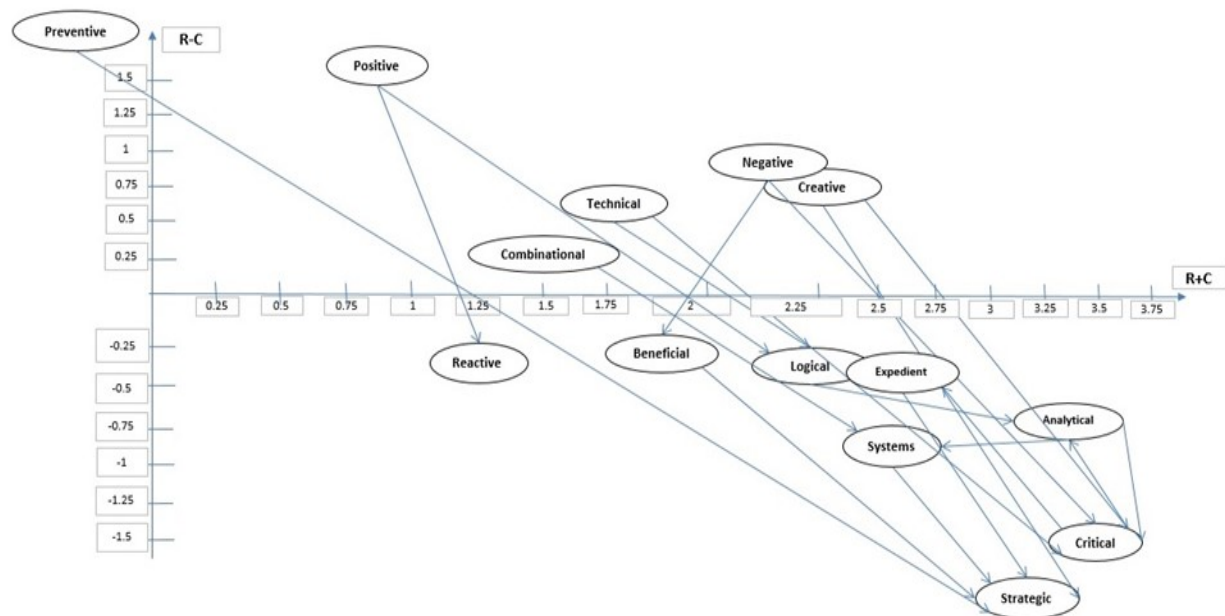


Figure 4. The relationship between different types of thinking styles based on the conducted research (Bakhshandeh and Zare Mehrjardi, 2019)

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.

¹ Decision-Making Trial and Evaluation Laboratory

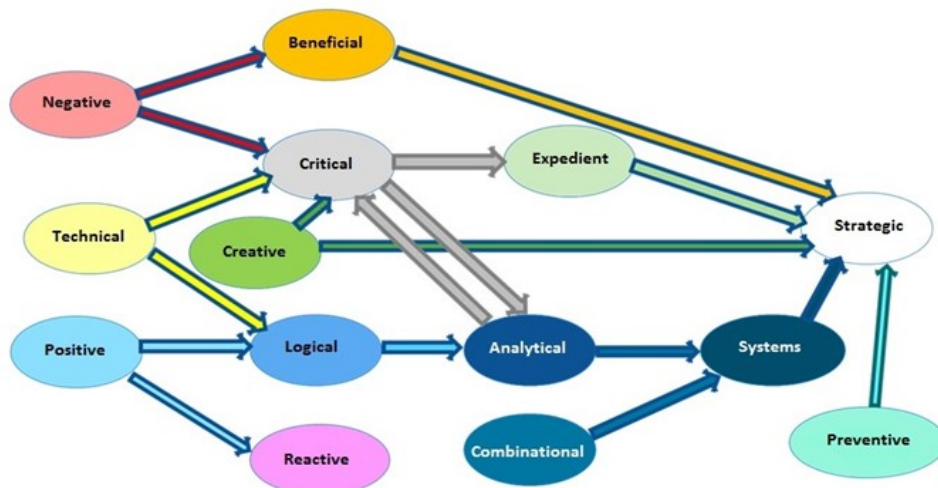


Figure 5. The relationship model of different types of thinking styles

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.

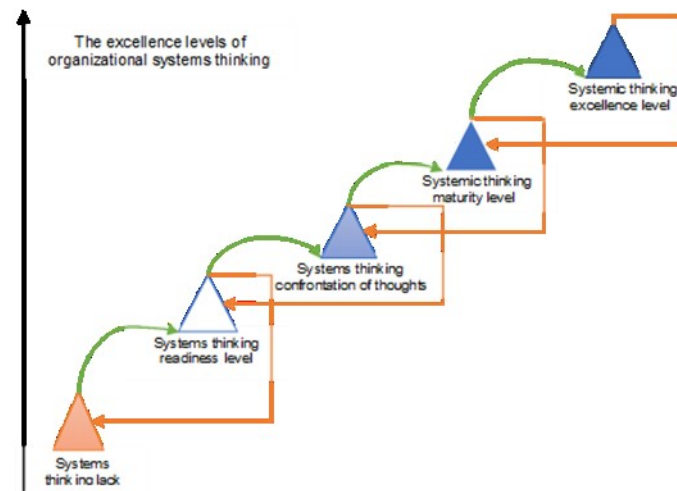


Figure 6. The excellence levels of organizational systems thinking (Bakhshandeh and Zare Mehrjardi, 2019)

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.

- (1) 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.
- (2) 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.
- (3) 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.
- (4) 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.

- (5) 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).

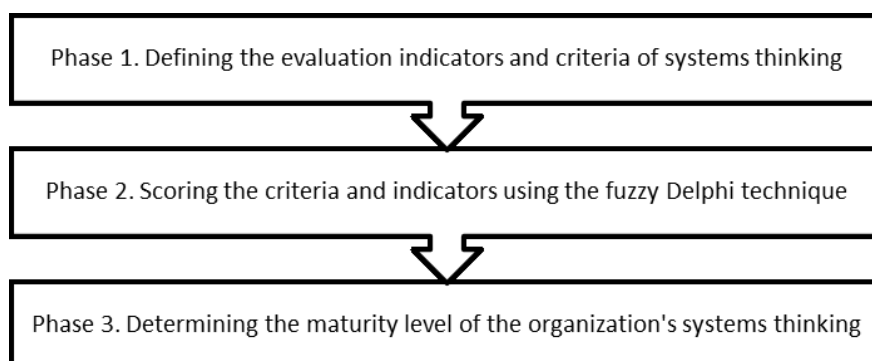


Figure 7. The Phases of Research Method

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 2. 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.

Index Title	Criterion Number	Criterion Title
	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.
	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 3. 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.

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

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).

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

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).

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

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 4. 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 5. 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 6. 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 7. 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 8. 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

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
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
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 9. 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 10. 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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