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Model of Dynamic Capabilities in Knowledge-Based Companies in the Gas-Refining Industry

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Highlights

- The purpose of the current research was to provide a model of dynamic capabilities in knowledge-based companies in the gas refining industry;
- All of their activities are research and development in the field of new, developable, and advanced technologies, which ultimately help the growth and development of the knowledge-based economy in the country;
- Considering the increasing importance and number of knowledge-based organizations in the country day by day and the complex, competitive, and unpredictable environment, the need for these types of organizations has become more prominent; the view of dynamic capabilities is one of the important ideas in this context.

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Abstract

Dynamic capabilities refer to an organization's capacity to purposefully create, expand, or change its resource base. The gas industry of each country plays an important role in its economy and growth. Further, we are in an era where rapid global changes and technological innovations occur, and gas refineries are not unaffected by these changes. Thus, the objective of this research is to identify dynamic capabilities within knowledge-based companies in the gas-refining industry. This study employs a mixed-method approach to develop a model of dynamic capabilities specific to knowledge-based gas-refining enterprises. By analyzing 54 articles through a meta-synthesis method and conducting semi-structured interviews with 12 experts in this field, we identified the components of dynamic capabilities through thematic analysis. Then, the factors were evaluated using confirmatory factor analysis, and a questionnaire was distributed to specialists, with all components being validated in the initial phase. This work utilized structural interpretive modeling (ISM) to develop the final model, and the corresponding questionnaire was completed by 15 managers of knowledge-based companies in Tehran.

Keywords: Dynamic capabilities approach, knowledge-based companies, Structural-interpretive modeling (ISM), Theme analysis approach

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1. Introduction

Today, the position and role of knowledge-based businesses in the development and progress of the country can be considered a vital role, and investing in this sector can lead to a knowledge-based economy. Governments consider knowledge-based organizations an important and key source in providing income and employment and an influential force in economic development and growth. A knowledge-based organization is a company or legal institution formed to transform knowledge and wealth by creating knowledge-based businesses. All of their activities are research and development in the field of new and developable and advanced technologies, which ultimately help the growth and development of the knowledge-based economy in the country. Considering the increasing importance and number of knowledge-based organizations in the country day by day and the complex, competitive, and unpredictable environment, the need for these types of organizations has become more prominent; The view of dynamic capabilities is one of the important ideas in this context. It is a field that can be somewhat responsive in very turbulent and complex situations.

2.Theoretical literature

2.1. Dynamic capabilities

According to Teece et al. (1997), dynamic capabilities include the company's competencies and abilities to integrate and reconfigure internal and external capabilities in order to respond to environmental changes. Dynamic capability is the capacity of companies to solve problems systematically by discovering and identifying opportunities and threats and making immediate decisions for appropriate changes (Abrate et al., 2020). Dynamic capabilities may sometimes be rooted in specific changes in routines (Aghimien et al., 2021) (e.g. product development along a certain path) and analysis (e.g. investment choices) (Jardon and Martinez-Cobas, 2021). However, they are mostly rooted in creative managerial and entrepreneurial actions (e.g., pioneering new markets) (Garrido-Moreno et al., 2020). They reflect the speed and degree to which the firm's specific resources/competencies can be aligned to match the opportunities and requirements of the business environment (Gonzalez and Melo, 2019). The nature of resources/competencies, as well as dynamic capabilities, is that they generally cannot be purchased. They must be built. As mentioned above, dynamic capabilities measure the capacity to realign, and resources/competencies are integrated and reintegrated to align with the business environment. Measurement, capture, and transformation are the specific characteristics of companies that enable them to evolve with the business environment. Such capabilities are critical for long-term profitability (Karman and Savanevičienė, 2021).

The dynamic capability perspective is currently considered one of the most reliable frameworks in the strategy agenda, which aims to identify the drivers of long-term survival and growth of the organization (Kevill et al., 2021). The purpose of the dynamic capability approach is to explain the competitive advantage of companies over time (Khan et al., 2020). The origin of this concept lies in strategic management, but it has been used in various fields such as marketing, entrepreneurship, risk management, and innovation management (Lim and Rasul, 2022).

How organizations achieve competitive advantage and superior performance has always been the focus of strategic management research. In this framework, we can refer to the resource-based perspective. The resource-based perspective (resource-based view) emerged as one of the key frameworks that explain competitive diversity and performance based on internal resources and served as an answer to overcome the limitations of industrial economics to explain superior company performance. Over time, researchers argued that sources of competitive advantage include external sources in addition to internal

sources. Especially as a result of the ever-increasing dynamism of the environment, the value created by the resources will become obsolete in the short term and will not be permanent for any firm.

Meanwhile, the resource-based view provides a static view of a company's resource portfolio. Therefore, based on extensive scientific calls in an effort to solve this shortcoming, the ground was provided for the emergence of the perspective of dynamic capabilities based on the findings of the perspective based on the sources of evolutionary economics and behavior theory. When the ability to use resources is proposed as a capability, the perspective of dynamic capabilities can justify many choices. In particular, the perspective of dynamic capabilities in strategic management indicates the necessity of simultaneously pursuing the search for new opportunities and at the same time benefiting from past achievements to shape the future of the company in the face of dynamic markets. While organizational capabilities enable the company to produce various products and services, dynamic capabilities guide and facilitate the development of its organizational capabilities through changing and manipulating the company's basic resources.

2.2. Knowledge-based companies

One of the requirements of innovation that can prevent failure is strategy; in an organization, if people imagine that they should think without any specific framework, it causes problems because there are no boundaries and limits (law). It does not exist for thinking, and it contradicts the productionist's point of view, which is thinking in the direction of production. Although a productive idea may arise with a very low probability (one in a million), it will lack economic efficiency (Murschetz et al., 2020).

If it works effectively, it should focus on creativity and the defined program within the scope of the strategy. Although having a strategy explains the main mission of the organization, it should be a suitable environment for the emergence of thoughts and ideas in the relevant areas; the main attention of management issues was around large companies until the early 60s. However, in recent years, small or medium-sized companies have been recognized as the engine of economic growth in the economic development and progress of countries. Therefore, according to the European Union standards, they have stated several definitions for small and medium enterprises; the most important feature and advantage of this type of enterprises is that the number of their employees is less than 250 people, and their annual turnover is from not more than 40 million Euros (Nayal, Pandey, and Paul, 2022).

A review of the existing literature in this field shows that there is no single definition of a knowledge-based organization, and different people have conceptualized this type of organization with different approaches. Some researchers have defined a knowledge-based organization as equivalent to a learning organization; knowledge-based organizations have the characteristics of learning organizations, but the most important thing in these organizations is the wealth and value creation by relying on resources and knowledge products that are objectified in the form of supplying software, technologies, and technical and specialized services with high added value (Obaya et al., 2020). Based on the definition provided in the law on the protection of knowledge-based companies and institutions and the commercialization of innovations and inventions, knowledge-based organizations are institutions working in the field of superior technologies with much added value to synergize knowledge and wealth, develop a knowledge-based economy, and achieve scientific and economic goals, including expansion and application of invention and innovation and commercialization of research and development results (design and production of goods and services). The survival of knowledge-based organizations depends on the creation of knowledge through research, and their prosperity depends on knowledge innovations (Olazabal Avila, 2022).

2.3. Knowledge-based companies and dynamic capabilities

This section discusses the overlapping of the two main theoretical fields of the current research: dynamic capabilities and knowledge-based companies. For this purpose, we first present a report of the researches conducted in this field and then review the literature based on what is presented from each of these concepts. We will explain the theoretical justification of the existence of the relationship between them, and the theoretical basis of the research will finally be explained by identifying the existing common areas.

3. Research background

Teece and Pisano (1997) have answered this question through the lens of dynamic capabilities. In the research literature, there is a variety of concepts of dynamic capabilities. According to Tice et al. (1997), dynamic capabilities are the ability of the company (organization) to learn to create internal and external resources and capabilities, as well as their combination and coordinated use in order to manage rapid environmental changes and adapt to these changes. Chen et al. (2009) in an article entitled "Creating Global Dynamic Capabilities Through Innovation: a Case Study of Cultural Organizations in Taiwan" analyzed the global dynamic capabilities that are the specific advantages of a company and the international expansion of cultural companies in Taiwan from the perspective of sustainable development. They identified six dynamic capabilities as the driving forces behind the creation of new cultural products that revitalize the firm through continuous innovation. Any global dynamic capability actually leverages company resources. The results of the case study show that the global dynamic capabilities of technology-based companies help cultural organizations to globalize their business and create value. In their study, they introduce two ways to develop universality that cultural organizations can use to increase value.

In an article entitled "Learning Capabilities and Growth of New Technology-Oriented Venture Businesses", Strehl et al. (2010) considered the effect of organizational learning as an endogenous growth driver for new technology-oriented venture businesses. This study analyzed the growth path of 34 companies whose capital was at least partly provided by venture capital during a 12-year period. This study showed that the adoption of eight sets of systems, used as indicators of the emergence of dynamic capabilities, had a positive correlation with the growth of venture business.

Sohrabi et al. (2017) investigated the identification and ranking of factors affecting the promotion of dynamic capabilities in small and medium industries (case study: Kurdistan industries) using the interpretive structural modeling (ISM) and DEMATEL models. The structural model showed that the variables of government policies, laws, and regulations act as the foundation stone of the model and are placed in the category of independent variables; they have high guiding power and low intensity of dependence and should be emphasized in the first stage in order to start promoting dynamic capabilities. They are related or connected, with a high power of direction and dependence, and any kind of change in them can affect other factors. Further, in the comparative analysis of the DEMATEL method, the industrialization culture variable was determined as the most effective factor.

Tamito et al. (2024) provided a comprehensive review of themes surrounding technology entrepreneurship and examined the challenges of technological entrepreneurship. While technology offers numerous opportunities for entrepreneurs to improve business processes and increase profit margins, it also brings significant challenges. Pournamati et al. (2024) investigated the impact of dynamic capabilities on company performance with the role of innovation capabilities, competitive advantage, and moderating entrepreneurial orientation. The research results showed that dynamic capabilities had an impact on innovation capabilities.

In an article entitled "Knowledge-Oriented Dynamic Capabilities and Worker Productivity in Professional Service Companies with the Transforming Role of Organizational Culture", Khaksar et al. (2024) investigated the relationship between two factors in knowledge management: Knowledge-oriented dynamic capabilities and knowledge worker productivity. This study examined the effect of organizational culture (adaptability, stability, job involvement, and mission) as a transforming variable on the relationship between the factors.

4. Research methodology

Since the main goal of this work is to identify dynamic capabilities in knowledge-based companies in the oil and gas industry in terms of the fundamental goal development by an inductive method and in terms of the collecting data method, it is a combined review. It is a systematic and content-analysis study. The present work attempts to identify dynamic capabilities in knowledge-based companies by conducting a systematic review without considering the time frame. After identifying these capabilities in knowledge-based companies using semi-structured interviews with Iran's knowledge-based companies active in the oil and gas industry and combining the data obtained in two stages, we can propose a comprehensive model of dynamic capabilities in this field.

4.1. First part: System overview

Feig (2005) reviewed a systematic, clear, and repeatable plan for identifying, evaluating, and interpreting recorded documents. Literature reviews often pursue two main goals: They summarizes current studies by identifying patterns, themes, and issues. Second, they help identify the conceptual content of a field and play a role in the development of theory. In the following, the steps of the systematic review are given in order (Naghandbaba, Duncan, and Dahmer, 2020).

4.1.1. The first step: Setting research question

Research parameters include *what* (what is being studied), *who* (community under study), *when* (time limit), and *how* (methods of research data collection); they are formed using research questions (Soering and Muller, 2008).

4.1.2. The second step: Systematic search

The present study was searched in online databases systematically to identify the literature related to dynamic capabilities. Therefore, in terms of the type of documents, thesis studies, book chapters, and editor's notes were not considered in this work.

4.1.3. The third step: Evaluation and selection of appropriate texts

The documents found in the previous step were examined based on different criteria to evaluate and select appropriate texts in this step.

4.1.4. The fourth step: Extracting information of articles

After examining and combining the results, the components of dynamic capabilities extracted from the literature review and systematic review were categorized. The basis of the extracted dimensions is 106 features identified from the synthesis of 54 articles that were selected in a systematic way. The results include 11 comprehensive components, 35 organizing components, and 106 basic components.

4.1.5. Validity and reliability

The Kappa index was used to measure the reliability of the research. This index was invented by Cohen (1960) and is used to calculate the expected consistency. The Kappa index obtained is higher than 0.8,

which indicates a high level of agreement between the two coders. As a result, the hybrid method of this research has the necessary reliability.

4.2. The second part: Analysis of theme

After systematically identifying dynamic capabilities in knowledge-based companies in this stage (second stage), we examined and completed the dimensions of dynamic capabilities in knowledge-based companies in the oil and gas industry. Using a semi-structured interview of research participants and conducting thematic analysis, we tried to identify these capabilities in knowledge-based companies in the field of oil and gas industry. There are different methods for theme analysis, each of which follows specific processes. This work uses the method of Brown and Clark (2006), which is a systematic approach to theme analysis and has been widely accepted. This method provides a step-by-step and comprehensive process for analyzing the theme. This theme analysis process is introduced in the form of three stages. The theme is a meaningful and coherent pattern of data related to the research questions. If we consider the codes as the bricks of a house, the themes are the walls and roof of the house. Searching for themes is an active process, that is, the researcher creates or constructs themes instead of discovering them. Themes are divided into three levels: basic or main themes, organizing themes, and overarching themes (Nim et al., 2023).

The statistical population of the current research in the second part (theme analysis) includes 15 people: managing directors and experts of knowledge-based companies active in the oil and gas industry; participants' specifications are given in Table 2.

4.2.1. The first step: Knowing data

When starting the thematic analysis, the researcher may collect the data himself or may be provided with the data by other researchers.

4.2.2. Second step: Creating initial codes

It starts when the researcher has studied the data and become familiar with them. Also, the researcher prepares a preliminary list of ideas in the data and their interesting points.

Table 2

The profile of the research participants

No.	Position	Field of study	Level of study	Interviewee code	Company name
1	CEO	Business management–human resources	PhD	A	**Aban Air Cooler Company**
2	Sales and marketing manager	Business management–human resources	Master's degree	B	Iliya Danesh Company
3	Senior expert of research and development unit	Financial management	PhD	C	Pars Pardaz Company
4	CEO	Financial management	Bachelor's degree	D	Delta Gas Mobin Company
5	Human resources manager	Business management–human resources	Master's degree	E	Proshad Palad Refining Industries Company
6	Senior expert of research and development unit	Government management	Master's degree	F	Taa Tos Company

No.	Position	Field of study	Level of study	Interviewee code	Company name
7	Sales and marketing manager	Financial management	PhD	G	New Energy Development Company
8	CEO	Government management	Bachelor's degree	H	Ardabil Industrial Milk Company
9	CEO		Bachelor's degree	I	Ardabil Industrial Milk Company
10	Human resources manager	Management of industries	PhD	J	Ardabil Industrial Milk Company
11	Sales and marketing manager	Business management–human resources	PhD	K	Petro Tamin Fahm Company
12	CEO	Management of industries	Master's degree	L	Kaush Sanat Tus Company

4.2.3. The third step: Searching for themes

The third step begins when all the data are initially coded and collected, and a long list of different codes is known in the data set. This step focuses on the macro level analysis of the codes.

Table 3 presents 110 basic and 41 organizing themes, and finally 14 overarching themes are identified in this research. In order to measure and control the quality of the results in the thematic analysis method, or in other words, to measure the reliability of the research, the Kappa index is used. The Kappa index obtained is higher than 0.8, which indicates a high level of agreement between the two coders. As a result, the content analysis method of this research has the necessary reliability.

4.3. Final coding after super composition and theme analysis

Based on the codes extracted from the met composition and content analysis, we can see the final codes extracted from both methods, as presented in Table 3.

Table 3

The final identified themes

Basic themes	Organizer themes	Main themes
1. Promotion of knowledge culture 2. Create interaction and open communication	1. Cultural infrastructures for the establishment of knowledge management	1. Knowledge management
3. Identifying and prioritizing internal needs 4. Regular evaluation of employees	2. Educational needs assessment and attention to the knowledge gap	
5. Documenting and storing knowledge 6. Protection of knowledge assets against loss or unauthorized access 7. Continuous improvement and promotion of knowledge assets through learning	3. Organization of knowledge	
8. Ability to adapt and modify knowledge in response to new information, technology, or market conditions 9. Practical use of knowledge to solve problems	4. Application of knowledge	

Basic themes	Organizer themes	Main themes
10. Effective communication and presentation of data for use by stakeholders 11. Facilitating the exchange of knowledge between individuals and teams within the organization	5. Sharing and sharing knowledge	
12. Organizational culture 13. Decision making in unstructured situations	6. Background conditions for decision-making	
14. Abandoning old methods and solving problems with new methods 15. Contingent thinking 16. Effective communication 17. Quick correction of incorrect decisions and stopping the continuation of the loss operation 18. Decision-making based on market research 19. Cost-benefit analysis before making a decision 20. Decision-making based on feedback obtained from the environment 21. Decision time management	7. Decision-making approaches	2. Ability to make decisions and solve problems
22. Closeness of individual beliefs with organizational foundations 23. Closeness of individual goals with organizational goals	8. Compatibility of values and goals	
24. Suitability of personality characteristics (extroversion, introversion, flexibility, and responsibility) with job 25. Applying the necessary conditions to do a job	9. Personality compatibility	3. Managing the fit of the individual with the organization
26. Proportion of skills of supervisors with skills of employees 27. The fit of the organization's job needs and individual skills	10. Compatibility of skills with individual characteristics	
28. Interaction of high and low levels in a friendly environment 29. Freedom to express criticisms and suggestions 30. Adaptability 31. Online meetings	11. Continuous learning	4. Space for discussion and feedback
32. Face-to-face meetings 33. Open dialogue	12. Conversation tool	
34. Mutual networks 35. Organic structures 36. Attention to the flexibility of capabilities	13. Structural features	
37. Establishing frequent feedback mechanisms between employees and management 38. Clear communication	14. Agile processes	5. Organization agility
39. Increasing the sense of responsibility, especially in times of change 40. Adaptability, flexibility, and speed of action	15. Agile employees	
41. Recognition and identification of talented employees 42. Establishment and employment of employees	16. Talent search	6. Talent management

Basic themes	Organizer themes	Main themes
43. Training and improvement of employees 44. Making the job attractive 45. The spirit of coaching and facilitation 46. High communication skills and flexibility	17. Talent development	
47. Collaborating and exchanging ideas with members 48. Existence of experienced, successful, and flexible managers 49. Emotional intelligence and reasoning intelligence	18. Psychological characteristics	7. Manager capability
50. New ideas of commercialization of activities 51. Adaptability 52. Ability to solve problems	19. Key capabilities of managers	
53. Implicit knowledge engineering 54. The spirit of search and the expertise and skill of the employees 55. Openness to welcome experiences 56. Intuitive	20. Personal ability and specialized ability	8. Academic staff
57. Sensualist 58. Questionnaire research, reports, and approvals	21. Method of collecting information	
59. Fame and reputation and profit 60. Access to new markets and groups 61. Access to new technologies or ideas	22. Motivation for the start-up company	
62. Accelerating your innovation processes and outputs 63. Reducing research and development time and costs	23. Motivation for big company	
64. Suitability of the parties (goal-strategy) for cooperation 65. Transparency of goals and tasks and cooperation capacity	24. Features affecting cooperation	9. The cooperation of a start-up company with a large company
66. Government policies 67. Facilitating institutions 68. Training and development	25. Infrastructure improvement factors	
69. The difference between norms and value system 70. Fear of imitation of innovative ideas	26. Cooperation risks	
71. Risk taking 72. Ability to communicate effectively	27. Characteristics of entrepreneurial people	
73. Creating a supportive atmosphere to increase employees' creativity and encourage innovation 74. Using new technologies	28. Creating a creative and innovative culture	
75. Expanding market research and identifying the target market 76. Introducing a new product to the market 77. Investing in research and development 78. Identifying technological opportunities	29. Targeted marketing	10. Technological entrepreneurship
79. Finding ideas and screening ideas- 80. Development of business model and plan 81. Product innovation 82. Process innovation	30. Entrepreneurial processes	
83. Intellectual capital and intellectual property protection law 84. Insurance and tax laws	31. Environmental factors	

Basic themes	Organizer themes	Main themes
85. Relations (government, industry, and university)		
86. Environmental uncertainties		
87. Attracting investment for technology development		
88. Government policies		
89. Organizational structure		
90. Cooperation networks with universities and other research centers and competing companies	32. Organizational factors	
91. Energy recovery from exhaust gases	33. Optimizing energy consumption	11. Cyclic supply management
92. Clean energy production		
93. Improving recycling management processes	34. Improving environmental goals	
94. Production of new materials using waste		
95. Leadership empowerment	35. Digital capacity building	
96. Organizational infrastructure		
97. Communication channels and networks		
98. Digital maturity level readiness		12. Digitization process
99. Standardization and modification of processes	36. Digital facilitators	
100. Effective investment		
101. Creating a digital mindset	37. Digitization capabilities	
102. Looking for digital trends		
103. Coordination between units	38. Integration of processes	
104. Improving decision-making		
105. Aligning the company's capability with environmental changes	39. The intelligence of the organization	13. Integrated management
106. Targeted research and development activities		
107. Selling more value-added products	40. Adding value due to sweetening gas products	
108. Reducing production costs		14. Gas product sweetening plan
109. Using artificial intelligence and machine learning	41. Dynamics in quality management	
110. Responding to the requirements and legislative bodies		

The results of processing 110 basic and 41 organizing themes are presented in Table 3, and finally 14 overarching themes are identified in this research.

4.4. Analysis

4.4.1. Confirmatory factor analysis in partial least squares approach fitting measurement part of model

To check the reliability of the reagents, the factor loading test is used, and in this test, the factor loading of the reagents must be higher than 4.0. Questions with a factor loading of less than 4.0 should be removed unless that question has a high convergence validity with other questions, where the researcher is not allowed to remove the question.

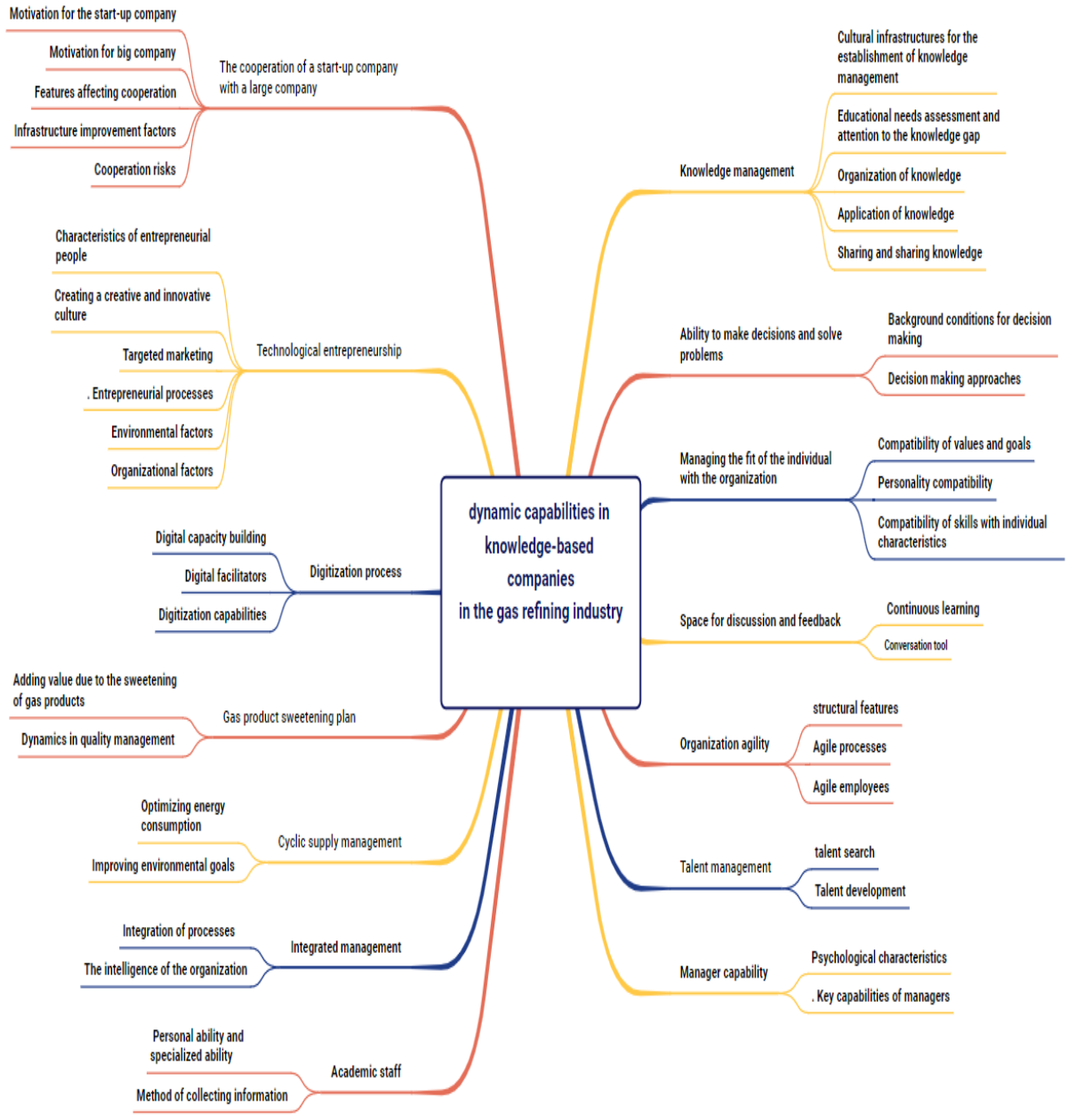

Figure 2

The theme network

4.4.3. Significance coefficient of factor loadings of research

The strength of the relationship between the factor (the latent variable) and the observable variable is shown by factor loading. Factor loading is actually a correlation coefficient between latent variables and manifest variables in a measurement model. This coefficient determines how much the latent variables explains the variance of the manifest variables. Since it is a correlation coefficient, it must be statistically significant. The significance of the factor loading is checked with the t-value statistic. Because significance is checked at an error level of 0.05, if the amount of factor loading observed with the t-value test is calculated to be smaller than 1.96, the relationship is not significant and the question should be removed from the research.

4.4.4. Cronbach's alpha

A traditional method for measuring the reliability of structures is Cronbach's alpha, the limit of which is 0.7. Table 4 lists the Cronbach's alpha of the variables.

Table 4

The reliability of the constructs through Cronbach's alpha

Variable	Cronbach's alpha
Personal ability and specialized ability	0.841
Conversation tool	0.817
Value addition due to sweetening gas products	0.827
Talent cultivation	0.847
Talent search	0.773
Integration of processes	0.772
Motivation for big company	0.718
Motivation for the start-up company	0.910
Creating a creative and innovative culture	0.830
Targeted marketing	0.857
Improving environmental goals	0.789
Optimizing energy consumption	0.917
Application of knowledge	0.806
Digital facilitators	0.732
Share and share knowledge	0.772
Ability to make decisions and solve problems	0.868
Method of collecting information	0.843
Decision making approaches	0.888
Cooperation risks	0.844
Cultural infrastructure	0.727
Organization of knowledge	0.727
Compatibility of values and goals	0.823
Personality compatibility	0.865
Compatibility of skills with individual characteristics	0.862
Background conditions of decision-making	0.749
Gas products sweetening plan	0.791
Digital capacity building	0.939
Infrastructure improvement factors	0.856
Organizational factors	0.800
Environmental factors	0.933
Digitization process	0.927
Agile processes	0.811
Entrepreneurial processes	0.928
Space for discussion and feedback	0.890

Variable	Cronbach's alpha
Manageability	0.813
Digitization capabilities	0.840
Ability of academic staff	0.898
Key capabilities of managers	0.759
Dynamic capabilities in knowledge-based companies	0.987
Talent management	0.830
Cyclic supply management	0.922
Management of individual-organization fit	0.865
Knowledge management	0.845
Integrated management	0.819
Educational needs assessment	0.779
The cooperation of a start-up company with a large company	0.928
The intelligence of the organization	0.874
Characteristics of entrepreneurial people	0.746
Characteristics affecting cooperation	0.832
Psychological characteristics	0.848
Structural features	0.722
Dynamics in quality management	0.781
Organizational agility	0.838
Technological entrepreneurship	0.962
Agile staff	0.749
Continuous learning	0.818

4.4.5. Combined reliability

In research that uses the partial least squares method, reliability must be calculated for constructs and indicators. Reliability was checked by Dillon–Goldstein coefficient (composite coefficient). Acceptable value for this coefficient is at least 0.7.

Table 5

The reliability of constructs through composite reliability (CR)

Variable	CR
Personal ability and specialized ability	0.890
Conversation tool	0.892
Value addition due to sweetening gas products	0.920
Talent cultivation	0.929
Talent search	0.898
Integration of processes	0.897
Motivation for big company	0.840
Motivation for the start-up company	0.957
Creating a creative and innovative culture	0.922
Targeted marketing	0.933
Improving environmental goals	0.905

Variable	CR
Optimizing energy consumption	0.960
Application of knowledge	0.912
Digital facilitators	0.881
Share and share knowledge	0.897
Ability to make decisions and solve problems	0.896
Method of collecting information	0.905
Decision making approaches	0.913
Cooperation risks	0.928
Cultural infrastructure	0.879
Organization of knowledge	0.850
Compatibility of values and goals	0.919
Personality compatibility	0.937
Compatibility of skills with individual characteristics	0.935
Background conditions of decision-making	0.888
Gas products sweetening plan	0.865
Digital capacity building	0.956
Infrastructure improvement factors	0.914
Organizational factors	0.909
Environmental factors	0.947
Digitization process	0.941
Agile processes	0.888
Entrepreneurial processes	0.943
Space for discussion and feedback	0.916
Manageability	0.867
Digitization capabilities	0.925
Ability of academic staff	0.920
Key capabilities of managers	0.891
Dynamic capabilities in knowledge-based companies	0.988
Talent management	0.888
Cyclic supply management	0.941
Management of individual-organization fit	0.901
Knowledge management	0.879
Integrated management	0.881
Educational needs assessment	0.900
The cooperation of a start-up company with a large company	0.939
The intelligence of the organization	0.941
Characteristics of entrepreneurial people	0.887
Characteristics affecting cooperation	0.923
Psychological characteristics	0.898
Structural features	0.878
Dynamics in quality management	0.901
Organizational agility	0.879
Technological entrepreneurship	0.965
Agile staff	0.889
Continuous learning	0.892

4.4.7. Formal narrative

A preliminary and minimal indicator of content validity is face validity. Face validity shows the items that are expected to measure a concept. They measure the appearance of the concept and seem to measure the concepts. In face validity, we actually check whether the experts confirm that the instrument measures the same thing as what is inferred from it or not. In this research, face validity was done with the opinion of respected professors (supervisors and advisors), and the questionnaire was approved under the supervision of these professors. After the respected professors approved the questionnaire in terms of form and content, the questionnaire was distributed among the statistical sample.

4.4.8. Divergent validity

To check the divergent validity, we used Fornell and Larcker's method, in which the correlation of a structure with its indicators is compared against the correlation of that structure with other structures. Considering that the root value of the AVE of the underlying variables in the research is higher than the correlation value between them, the validity of the model's variance is at a reasonable level.

4.4.8.1. Final verified model of dynamic capabilities in knowledge-based companies in field of gas refining

The output of the model shows that the coefficient of significance between the research paths is out of the range of 1.96, indicating that all research variables are confirmed at a confidence level of 95% in the statistical sample, that is, the experts of knowledge-based companies in the field of gas refining.

Table 6

Divergent validity through the Fornell and Larcker's method

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ability to make decisions and solve problems	0.70													
Gas products sweetening plan	0.53	0.78												
Digitization process	0.57	0.57	0.82											
Space for discussion and feedback	0.59	0.53	0.56	0.80										
Manageability	0.64	0.50	0.50	0.50	0.72									
Ability of academic staff	0.50	0.56	0.63	0.63	0.63	0.771								
Talent management	0.56	0.51	0.56	0.59	0.55	0.52	0.82							
Cyclic supply management	0.54	0.50	0.51	0.57	0.52	0.64	0.51	0.87						
Management of individual-organization fit	0.67	0.58	0.51	0.57	0.59	0.63	0.53	0.73	0.78					
Knowledge management	0.65	0.68	0.53	0.53	0.57	0.58	0.52	0.66	0.55	0.86				
Integrated management	0.49	0.58	0.56	0.58	0.52	0.65	0.73	0.53	0.50	0.50	0.81			
The cooperation of a start-up company with a large company	0.67	0.77	0.52	0.56	0.59	0.62	0.56	0.54	0.52	0.56	0.57	0.75		
Organizational agility	0.52	0.66	0.54	0.54	0.59	0.59	0.69	0.65	0.72	0.66	0.51	0.67	0.72	
Technological entrepreneurship	0.57	0.82	0.52	0.54	0.51	0.50	0.53	0.59	0.56	0.51	0.50	0.51	0.66	0.76

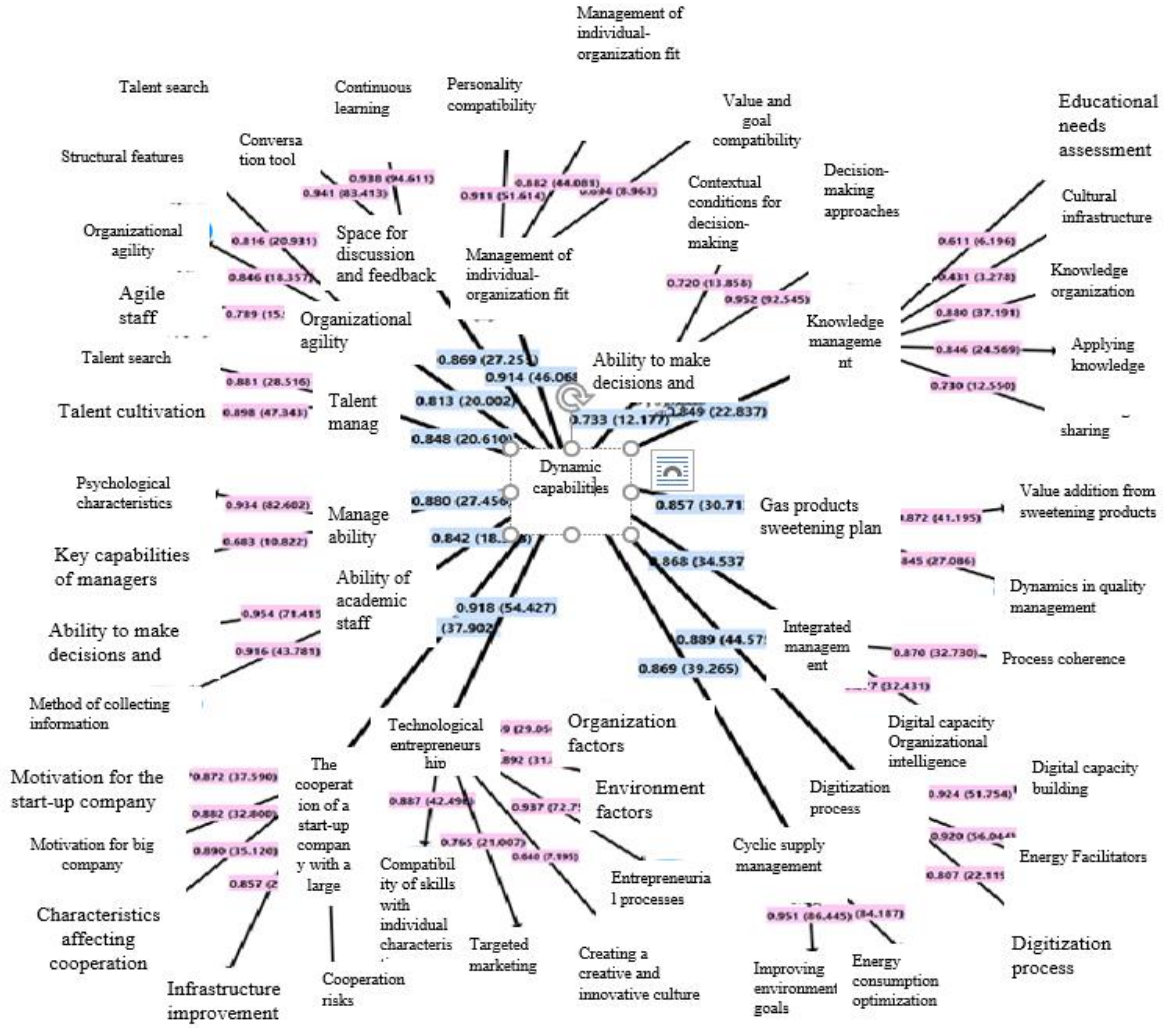

Figure 5

Verifying the theme network

4.4.9. Method of analysis in structural–interpretive approach

This section analyses the research data, and the aim of this research is to design a model of dynamic capabilities in knowledge-based companies in the field of gas refining. To this end, interpretive structural modeling (ISM) is employed.

5. Discussion and conclusions

The purpose of the current research was to provide a model of dynamic capabilities in knowledge-based companies in the gas refining industry. The method for conducting this study was mixed, and the current work consists of two qualitative and quantitative stages. Dynamic capabilities are first identified and extracted in scientific companies with the meta-combination method. At this stage, the content of 54 articles was carefully studied, and the basic capabilities were extracted. Then, using the theme analysis method, these features were modified and perfected. For socio-statistics in the qualitative phase of this work, we collected qualitative data by interviewing 12 managers and strategists of knowledge-based companies in the gas refining industry. Interviews were conducted with the desired people until the theoretical saturation stage. The sampling method in the qualitative phase of this research used the

purposeful and judgmental sampling method. Then, the interview texts from the data collected from the semi-structured interview and the implementation and analysis of these data were performed using a thematic analysis approach. The coding was also classified into three stages. In this way, the theme network of the components was compiled in the quantitative phase of the research using the identified codes from the previous phase (basic codes). The content validity index was good for 110 items, and then the questionnaire was given to experts and knowledgeable people in the gas refining industry. Further, for data analysis using SPSS 18, SmartPLS statistical software, we analyzed the theme network of the components of dynamic capabilities and confirmed the assumed relationships in the structural model. Moreover, the components were leveled using the interpretive structural modeling method, and the final model was presented.

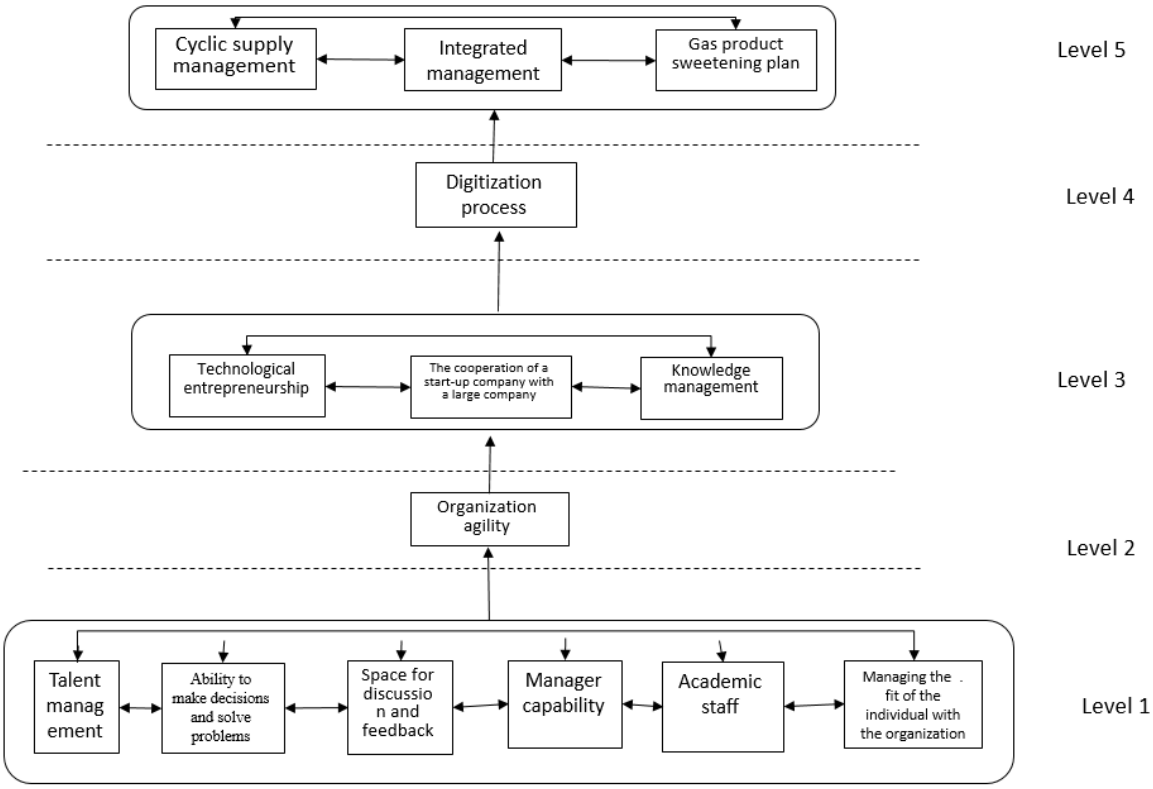

Figure 6

The interpretive structural modeling of the research

According to the findings of this study, the dynamic capabilities of knowledge-based companies in the gas refining industry include the following: knowledge management, employee-organization fit management, dialogue and feedback environment, organizational agility, decision-making and problem-solving abilities, talent management, capabilities of senior management, capabilities of knowledge workers, collaboration between startups and large companies, technological entrepreneurship, circular supply chain management, digitalization processes, integrated management, and sweetening of gas products.

5.1. Comparison of research findings with previous research findings

5.1.1. Talent management, ability of top managers, and knowledge workers

The findings of this research in the mentioned components are in line with the following previous researches:

The results of researchers such as Seyed Naqvi et al. (2022) and Abili et al. (2019) defined the talent recruitment process in two main processes: talent search and talent cultivation. These researchers emphasized the development of contexts that facilitate dialogue, participation and constructive opposition, the language of redefining social identities, people in trust-based relationships, and collective and group efforts in interpretations and discourses. The interviewees with great emphasis on the manager's clear communication with the employees, a lack of censorship, an atmosphere without fear, a flexible and friendly atmosphere and work environment, allowing comments and feedback to senior managers, feedback, tolerance of criticism, respectful criticism, atmosphere of dialogue, and empathy have emphasized creating a platform for boldness in expressing opinions. These researchers believe that managers should benefit from flexibility, high communication skills, and emotional intelligence against environmental changes and fluctuations.

5.1.2. Organizational agility

In this regard, the findings of this research in the field of organizational agility in knowledge-based companies in the gas refining industry are in line with the following previous researches: Wang et al. (2024) and Seyed Naqvi et al. (2022). They paid attention to factors such as the speed of action, the flexibility of capabilities, flexibility, fast and flexible human resources, creativity, teamwork, adaptability, flexibility and speed of action, and increasing the sense of responsibility, especially in the time of changes.

5.1.3. Space of discourse and feedback

The findings of this work in the field of space of discourse and feedback in knowledge-based companies in the gas refining industry agree with the following previous researches: Seyed Naqvi et al. (2022) and Wang et al. (2024), believing that factors such as the clear statement of the manager with the employees, no censorship, fearless space and flexible and friendly work environment, permission to express opinions, respectful criticism, and listening ears of the managers should be established to create a space of discourse and feedback in the organization.

5.1.4. Managing fit of individuals with organization

The findings of this study in the field of managing the fit of the individual with the organization in the knowledge-based companies of the gas refining industry are in line with the following works: Mohammadi (2021) and Vogel (2009), investigating the role of matching the values and goals of the individual with the organization and on the compatibility of the individual's personality and skills with the relevant organization.

5.1.5. Ability to make decisions and solve problems

The findings of this study in the field of ability to make decisions and solve problems in knowledge-based companies in the gas refining industry are consistent with the following studies: Seyed Naqvi et al. (2022) and Singh Sandhawalia (2013), stating that decision skills and effective decision-making are essential for employees and managers, where leaders must make informed choices that affect employees and the overall learning environment; they also believed that old decision-making methods must be abandoned and problems should be solved with new methods to achieve this.

5.1.6. Knowledge management

The findings of this work in the field of knowledge management in knowledge-based companies in the gas refining industry are in line with the following: Nowrozi et al. (2021) and Seyed Naqvi et al. (2022),

listing the components of knowledge management and identifying the key components of knowledge management that are very important for start-ups in the field of knowledge and information sciences.

5.1.7. Cooperation of young company with big company

The findings of this paper in the field of cooperation between a start-up company and a large company agree with the following works. Hora et al. (2018) believed that cooperation between young companies (start-ups) and larger and more established companies (large companies), on the one hand, provides an opportunity for start-up companies that face limited resources; on the other hand, large companies benefit from their innovative ideas. Beck et al. (2020), Chesberg (2021), and Muller et al. (2021) also investigated the motivations of cooperation for large and start-up companies, the risks of cooperation, and the characteristics affecting the cooperation of the two.

5.1.8. Technological entrepreneurship

The findings of this work in the field of technological entrepreneurship are in line with the following studies: Kohne Gourabi et al. (2021) investigated individual factors such as risk taking, effective communication ability, environmental factors, and organizational factors discussed about technological entrepreneurship. Stantij (2018) also studied environmental factors as well as environmental disturbance and its impact on technological entrepreneurship. Nik Behad (2021) believed that environmental and organizational factors significantly affected technological entrepreneurship.

5.1.9. Digitization process

The literature review shows that the findings of this paper in the field of digitization process agree with the following researches: Mel et al. (2023), Dimet Ray et al. (2023), and Kalabi et al. 2022). In this context, leaders play an important role in shaping organizational culture. A strong digital culture characterized by openness to change and continuous learning is essential to achieving higher levels of digital maturity. Leaders who foster this culture can increase employee engagement and commitment to digital transformation efforts. Process standardization is also essential for companies aiming to maximize the value of digital transformation initiatives; it acts as a fundamental element that can significantly affect overall performance.

5.2. Suggestions based on research findings

Informal communication and networks, in a way almost all the interviewees mentioned their importance, indicate the importance of interactions and the need to create scientific circles and group scientific activities among academic staff; among these activities can be synergistic knowledge centers. The continuous connection of universities with industry, knowledge diplomacy, and scientific discourse creation are mentioned. It is suggested that managers of knowledge-based companies should pay more attention to human concepts than before. Definitely, the more interaction and closeness are established between managers and members, the better they can overcome the challenges. The key to the success of the above companies is in the empathy and interaction of the members with each other and in particular the dialogue. Good ideas and solutions are obtained from these conversations.

The results of the analysis of the findings of the qualitative section revealed that the components of attracting, training, and improving talents affected the process of talent cultivation. Considering that the field of competition in this industry is becoming narrower day by day and since many knowledge-based companies in the gas refining industry have not been able to cooperate with gas refineries on a continuous basis, it is suggested that dynamic capability model be used before any action.

Nomenclature

CEO	Chief executive officer
CR	Composite reliability
DC	Dynamic capabilities
DEMATEL	Decision-making trial and evaluation laboratory
ISM	Interpretive structural modeling

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