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MODELLING SECTORAL INNOVATION SYSTEMS FOR SUSTAINABILITY (CASE STUDY OF IRANIAN FOOD INDUSTRY COMPANIES)

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Relevance. *Currently, in the literature on the study of the regional dimension of innovation systems, special attention is paid to the dynamics of development of regions and territories, as well as the sustainability of these innovation systems. In this study, there is no predetermined framework such as theory or model to find the key factors affecting innovation systems for regional sustainability for Iranian food industry companies. The suggested framework is designed based on the data that has been collected in the course of the study from the literature and empirical sources (interviews with experts). This framework can be used as a tool for strategic planning and futures research by managers.* ***The main goal*** *of this research is to design a model of innovation systems to provide sustainability of regions for food companies in Iran. Therefore, we seek to identify and prioritize the factors affecting innovation systems for regional sustainability and to analyze concepts such as innovation systems on the example of regional sustainability for food companies. The authors aim to find out the factors affecting the increase and decrease of the sustainability of regions.* ***Methods.*** *Analysis method, synthesis, FUZZY, Delphi, FAHP.* ***Results.*** *The factors impacting sustainability of regional innovation systems in the food industry were identified after studying the literature and interviewing professors and experts in the field of marketing and applying the Delphi method. The priority and significance of each of these factors were evaluated using the fuzzy hierarchical analysis methods after designing and distributing the questionnaire among food industry experts. The results of the fuzzy hierarchical analysis additionally revealed that the most significant factors of innovation systems to keep the sustainability of regions for food industry companies are: individual factors, organizational factors, material factors, and environmental factors, respectively. The results of the fuzzy hierarchical analysis additionally explained that the most significant individual factors of innovation systems are: motivation, courage, perseverance and persistence, independence, control center, ambiguity tolerance, self-confidence, and risk-taking. Additionally, the most critical organizational factors of innovation systems are: human, structural and cultural resources, respectively. The most essential material factors of innovation systems are: heavy exit costs, fear of losing profits, reduction of investment incentives, and fear of being abandoned, respectively. The most important environmental factors of innovation systems are: technology complexity, attention to the customer, technology infrastructure, competitive atmosphere, suitable economic conditions, and organizational dynamics, respectively. According to the acquired validity and reliability, the extracted model of innovation systems for regional sustainability can be utilized in applied and practical research.*

Key words: *Model of innovation, innovation, innovation system, sustainability, sustainability of regions.*

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Introduction

In today's world, the ability to adapt and manage changes is the key to the success and stability of any organization, and the attainment of these abilities requires the organization to pay attention to people's creativity and innovation. Sustainability is the desired use of resources in all aspects. Indeed, sustainability is a strategy to meet the needs of the world's population without undesirable impacts on health and the environment without destroying and threatening the global resource base, regardless of the ability of future generations to meet their needs [1]. Successful organizations are those ones in which creativity and innovation lead to their movement [2]. In other words, today's organizations must be dynamic to continue their operation and their managers and employees must be creative and innovative characters so that to be able to adapt the organization to these developments and satisfy the needs of society. It can be stated that creativity and innovation are the key to survival and the key to organizational success in the global economic system and increasing competition [3]. Today, the issue of innovation has drawn the attention of many scientists and researchers in different fields and has become very essential in today's profoundly changing organizations to compete and stay in the cycle of change, because innovation is an essential and vital factor for organizations to create sustainable competitive value and advantage in today's complex and changing environment. Organizations will be more prosperous in responding to varying environments and formulating and developing new abilities that allow them to achieve better performance [4]. Innovation, which is regarded as the source of the competitive position of leading organizations, emphasizes the open innovation approach, changing the perspective and the need for organizations to go beyond their borders to achieve external knowledge and technology instead of emphasizing the traditional model (closed innovation) which regards success exclusively in controlling internal resources and demands organizations to be self-sufficient in their research and development. Environmental uncertainty, complexities of innovation, and recombination of knowledge enhance the permeability of the organization's boundaries and increase the organization's interaction with its environment [5].

It is presently estimated that product innovation is originated from a variety of sources. Contemporary thinking based on methodical and systematic innovation says that innovation results from complex and long-term interactions between humans [6]. Nevertheless, innovation was simply recognized through knowing and researching technical solutions for a long time. Even today, in many cases, innovation points to the introduction of new technologies for a product or its production method in order to improve performance and usability or reduce prices [7]. Since the early 1990s, a new look was provided at customer satisfaction at the forefront of technological thinking about product innovation; a thought that caused innovation to be provided based on the new needs of the market. The idea of innovation, which includes increased attention to the needs and requirements of the customer, has latterly been introduced as an innovation resulting from design. This innovation is not in disagreement with technology and market innovation, but as a complement and based on satisfying the new needs of the market or the adherence of an existing product to new technologies [8]. On the other hand, today, many organizations and companies and many economic and social sectors have recognized the need for innovation (individual and organizational). This tendency is mainly due to the same complex new conditions and situations that have faced organizations with competitive and technological bottlenecks and the continuation of traditional methods has faced a new problem [9]. Hence, companies experience a lot of pressure to increase their capacity for innovation in many industries.

Even in today's challenging economic times, innovation is on the top of the list of managers' activities, although not everyone expects innovation to come from their own labs. A

company does not rely entirely on its own innovative resources for new technology, product, or product development. Rather, the company requires necessary inputs from external sources for this innovation [10]. In fact, the concept of sustainability has been key to the most pressing challenges of the century in global research, and programs in recent decades and sustainability or sustainable development has become an important field of research these days. The current challenge of developing in a sustainable direction is related to all sectors of society, including engineering and manufacturing [11]. Manufactured products influence three dimensions of sustainability (economical, environmental and societal ones) throughout their entire life cycle (extraction, production, transportation, use and disposal of materials) [12]. It was recognized that about 80 % of the effects of sustainability are set in the product design phase [13]. Design and production of sustainable products was recognized as an important strategy to achieve sustainability to address this issue in the production. The concept of sustainability in the 1970s was a logical response to global environmental and development issues. Ideas and approaches were required to be a new approach to the legacy of comprehensive urbanization after World War II and the expansion of industrial activities that reduced urban infrastructure and services and caused environmental waste [14]. Sustainability had been a preeminent objective in environmental and spatial planning for the past three decades. In fact, a series of different programs were considered and promoted in order to facilitate economic and social development and in order to reduce or reverse environmental damage [15]. The concept of sustainability and sustainable development was defined from different scientific perspectives that each definition was for a specific plan and was employed in different fields [16]. The presented definitions can be in the form of different concepts such as vision expression, exchange of values, moral development, social reorganization, transformation towards a better future, not jeopardizing the quality of the environment, empowering people, formulating new capacities, respect for indigenous information and knowledge, increasing awareness and information, leading people to the stage of life satisfaction and freedom of choice and equality in access to opportunities, all in a way describe the fundamental idea of sustainability, i. e. satisfying the requirements of the contemporary generation considering the requirements of future generations [17].

Attracting more resources and innovation is to produce a defense mechanism against active competitors, and utilize an approach to be present in all fields, by food industry companies. Modifying the structure of the innovation system of food industry companies and changing it from a traditional approach to a new approach in innovation systems is one of the principal steps in this direction that was produced in the innovative system. Recent trends in the food industry in Iran and the customer's attitude reveal that many problems have been formulated for food companies due to recent challenges and the poor performance of the food company. In this situation, all companies in the food industry are attempting to improve this situation to some extent, according to their activities in order to promote the innovation system for the sustainability of the regions. On the other hand, the concept of innovation systems for the sustainability of the regions was highly considered in these organizations due to the competitive environment in various industries, particularly the food industry, and the existence of many similarities in the field of products, but producing accurate and effective mental imagery on the minds of the target audience was not done correctly due to the many similarities in the food industry and the challenges. Meanwhile, food industry companies are also encountering challenges in the situation of innovation systems for the sustainability of regions due to the dominant atmosphere in the system. In this regard, food industry companies are facing challenges related to applying innovative strategies not only to heal the sustainability of regions, but also in order to confirm the relationship with their stakeholders and additionally

strengthen competitive advantages. In fact, the value of the company can be assessed by measuring the innovation system for the organization. Regrettably, this concept has not yet considered properly in Iran. Deficiency of knowledge in the field of innovation systems for the stability of the region in Iran results in nothing but customer dissatisfaction and reducing the customer loyalty to their potential loyalty. In this research, we try to examine this concept in the communication context of organizations and customers by offering the model of innovation systems for the sustainability of regions for food companies. In fact, the principal issue of this research is to design a model of innovation systems for the sustainability of regions for food companies in Iran. Accordingly, we try to identify and prioritize the factors touching innovation systems for the sustainability of regions. We need to examine how the concept of the innovation system is related to the sustainability of regions for food companies. Also, we attempt to identify the factors that increase and decrease the sustainability innovation systems.

Methodology

The research approach of the present study is qualitative. This research is exploratory in nature. Therefore, the present research method is Delphi. After carefully studying the literature sources, the current paper identifies the factors affecting the innovation systems for the sustainability of the regions (Table 1). Using the Delphi method, the conceptual model was advanced to the stage of consensus on the factors and components. These factors were identified according to the related definitions after considering them and eliminating duplicate ones and integrating similar factors, the latters were then provided to several experts and professors in the form of pairwise comparisons and they were asked to discover the significance of each of these factors in food industry companies. In the next step, the data were analyzed utilizing fuzzy analytical hierarchical process and then the factors that achieved the highest rank were placed to the final model.

Table 1. *Factors, components, and their description based on available literature studies*

Таблица 1. *Факторы, компоненты и описание в литературных источниках*

Description Описание	Components Компоненты	Factors Факторы
Individual factors Индивидуальные факторы	Courage Смелость [18–20]	A set of common values of risk-taking whether financially, psychologically or socially. Набор общих ценностей принятия риска в финансовом, психологическом или социальном плане.
	Tolerance of ambiguity Терпимость к двусмысленности [18, 21, 22]	This means that these people are highly adaptable in the face of unknown or undefined situations because innovative actions occur primarily as a response to ambiguity and are understood from within ambiguity. Therefore, ambiguity should always be treated as an opportunity. Люди легко адаптируются к неизвестным или неопределенным ситуациям, потому что новаторские действия происходят, в первую очередь, как реакция на двусмысленность. Следовательно, двусмысленность всегда следует рассматривать как возможность.
	Risk-taking Принятие риска [18, 20, 21]	One of the most important characteristics of innovative people is risk-taking. Thus, the nature of creativity indicates that this work is risky. Creative endeavors sometimes fail, but creative people need to be able to accept failure regardless of the risks. And the highlight of creative organizations is the commitment to risky resources to pursue creative possibilities. Одна из важнейших характеристик инновационных людей – это

		готовность к риску. Таким образом, в данном случае характер творчества указывает на то, что эта работа рискованна. Творческие начинания иногда терпят неудачу, но творческие люди должны уметь смириться с неудачей, невзирая на риски. А изюминкой творческих организаций является стремление использовать ресурсы, появляющиеся в результате рисковых ситуаций, для реализации творческих возможностей.
	Independence Независимость [19, 20]	Independent people decide for themselves what goal to choose or what to do? When to do it? How to do it? And when to stop it? In all these cases, the inner desires, preferences, and desires of individuals are the determinants of behavior, not external factors. Независимые люди сами решают, какую цель выбрать или что делать, когда это делать, как это сделать, а также когда и как прекратить эту деятельность. Во всех этих случаях внутренние желания, предпочтения и желания людей являются детерминантами поведения, а не внешними факторами.
	Self confidence Уверенность в себе [23–25]	Confidence basically refers to expecting to successfully overcome challenges and overcome obstacles. Or it generally refers to the belief, that one can move things according to one's inner desires and ensures the successful completion of a particular task or the development of a specific role. Уверенность в основном означает ожидание успешного преодоления трудностей и препятствий. Это обычно относится к убеждению, что человек может менять вещи в соответствии со своими внутренними желаниями и обеспечивает успешное выполнение определенной задачи или развитие определенной роли.
	Control focus Локус контроля [26, 27]	The center of control means that the individual (not fate) controls life course. Локус контроля означает, что именно личность (а не судьба) определяет жизнь.
	Motivation Мотивация [3]	Motivation is any kind of influence that strengthens, directs and evokes human behavior and creative and innovative behavior. Мотивация – это любое воздействие, которое усиливает, направляет и стимулирует человеческое поведение, а также творческие и новаторские начинания.
	Perseverance Настойчивость [3]	When a person spends a lot of time on a particular issue, there is a high probability that a new and valuable achievement will emerge from that work. Small steps that have been taken over a long period of time are merged to create a transformational breakthrough. Когда человек тратит много времени на какую-то конкретную проблему, высока вероятность того, что в результате этой работы появится новое ценное достижение. Маленькие шаги, которые были предприняты в течение длительного периода времени, могут сложиться в революционный прорывной результат.
Environmental factors Средовые факторы	Structural Структурные [3]	Organizational structure is the basis of organizational activities and changes require changes in organizational structure. The structure of the innovative organization should be a flexible one that facilitates the horizontal and vertical communication of the organization and facilitates and accelerates the conditions for creativity and innovation. Организационная структура является основой организационной деятельности, следовательно, изменения требуют изменений в организационной структуре. Структура инновационной организации должна быть гибкой, чтобы облегчить горизонтальную и вертикальную коммуникацию организации, а также облегчить и ускорить создание условий для творчества и инноваций.
	Cultural Культурные [3]	Innovative organizations have similar cultures. They encourage experimentation and reward both success and failure. They admire mistakes. Unfortunately, in many organizations, people are rewarded for not failing and not because of success. У инновационных организаций схожая культура. Они поощряют

		эксперименты и вознаграждают как успехи, так и неудачи. Они восхищаются ошибками. К сожалению, во многих организациях людей вознаграждают за то, что они не потерпели неудачу, а не за успех.
	Human resources Человеческие ресурсы [3]	Innovative organizations actively promote the training and development of their members to keep abreast of current issues. They give their employees high job security so that employees are not afraid of being fired if they make a mistake, and they encourage people to change heroes. Инновационные организации активно способствуют обучению и развитию своих членов, чтобы быть в курсе текущих проблем. Они обеспечивают своим сотрудникам высокую гарантию занятости, чтобы сотрудники не боялись увольнения в случае ошибки, и поощряют людей сменять героев.
Environmental factors Средовые факторы	Competition atmosphere Кокуренция [3]	The complex competitive environment does not allow organizations to stand still and the condition for their survival is dynamism, foresight, and productivity. The solution to meet these conditions for any size and any type of organization is organizational innovation. Сложная конкурентная среда не позволяет организациям стоять на месте, условием их выживания является динамизм, дальновидность и продуктивность. Решением для удовлетворения этих условий для любого размера и типа организации являются организационные инновации.
	Suitable economic conditions Подходящие экономические условия [3]	Organizations must plan their activities based on the state of the environment. Improper planning and inadequate attention to the economic situation of the environment has failed many organizations. Организации должны планировать свою деятельность, исходя из состояния окружающей среды. Неправильное планирование и недостаточное внимание к экономической ситуации во внешней среде подвели многие организации.
	Organizational dynamics Организационная динамика [3]	Dynamics refers to the continuity of changes in the corporate environment, which is due to the process of technology and competition. Dynamics also indicates instability of perception and continued changes in the firm market. Под динамикой понимается непрерывность изменений в корпоративной среде, обусловленная технологическим процессом и конкуренцией. Динамика также указывает на нестабильность восприятия и продолжающиеся изменения на рынке фирм.
	Technology infrastructure Технологическая инфраструктура [25, 28–30]	This is an undeniable fact if there is a growing and progressive relationship between universities, government research institutes, R&D departments of production unions and science and technology parks with companies, all processes in innovation projects can be affected. These centers can be used as a reliable source to provide the technology needed for innovation projects. Если между университетами, государственными исследовательскими институтами, научно-исследовательскими отделами фирм, научно-техническими парками и компаниями будут развиваться все более прогрессивные отношения, это может повлиять на все процессы в инновационных проектах. Эти центры можно использовать в качестве надежного источника технологий, необходимых инновационным проектам.
	Attention to the customer Внимание к клиенту [3]	All innovators must emphasize the value of creativity to meet customer needs since the customer is both internal and external. Interacting with customers and understanding their needs is one of the best ways to discover new opportunities and capabilities and motivation to implement them. Все новаторы должны подчеркивать ценность творчества для удовлетворения потребностей клиентов, поскольку клиент является

		как внутренним, так и внешним. Взаимодействие с клиентами и понимание их потребностей – один из лучших способов открыть для себя новые возможности и мотивацию для их реализации.
	Technology complexity Сложность технологии [25, 28–30]	Complexity of a new technology to be applied in an innovation project has a significant impact on its implementation. In addition to the complexity of the technology used, the personnel involved in the innovation project have an understanding of the flow of information about the project. Сложность новой технологии, применяемой в инновационном проекте, оказывает значительное влияние на ее реализацию. Помимо сложности используемой технологии, персонал, задействованный в инновационном проекте, имеет представление о потоке информации о проекте.
Material factors Материальные факторы	Fear of losing revenue Страх потерять доход [31]	The greater the investment in innovation projects, the more likely they are to be radical, and vice versa. That is if there are little financial resources available for companies to invest, the tendency to invest in (gradual innovations) increases. Чем больше вложения в инновационные проекты, тем больше вероятность, что они будут радикальными, и наоборот. То есть, если у компаний мало финансовых ресурсов для инвестирования, тенденция инвестировать в постепенные инновации возрастает.
	Reducing investment incentives Снижение инвестиционных стимулов [28]	
	Fear of being abandoned Страх быть брошенным [32]	
	Cost of losing employees [30] Стоимость потери сотрудников	

Discussion

Descriptive findings

As it is shown in Table 2, a total of 26 people were included in this study, 2 people (8,0 %) are at the age of 30 to 40 years and 10 people (38,0 %) are between the ages of 40 and 50 years and 14 people (54,0 %) are over the age of 50. In terms of educational level, 2 people (8,0 %) have a master's degree, 6 people (23,0 %) are PhD students and 18 people (69,0 %) have a PhD degree or higher.

Table 2. *Demographic characteristics of the sample (n=26)*
Таблица 2. *Демографические характеристики выборки (n=26)*

Field variable Переменная	Value Значение	Frequency Частота	Percentage Процент	Field variable Переменная	Value Значение	Frequency Частота	Percentage Процент
Age Возраст	25–30 years 25–30 лет	0	0,0	Education Образование	Bachelor Бакалавр	0	0,0
	30–40 years 30–40 лет	2	8,0		MA Магистр	2	8,0
	40–50 years 40–50 лет	10	38,0		Ph.D. Student Аспирант	6	23,0
	Over 50 years Старше 50 лет	14	54,0		Ph.D. and above Кандидат наук и выше	18	69,0

Inferential findings

26 questionnaires were used to analyze the factors. According to the preliminary results of the Principal Component Analysis (PCA) of the research tool, all items have the appropriate factor load and no item is removed from the questionnaire.

Table 3. *Results of the Kendall's Coefficient of Concordance*
Таблица 3. *Результаты коэффициента соответствия Кендалла*

Number/Количество	26
Kendall's Coefficient of Concordance Коэффициент соответствия Кендалла	0,725
Chi-square/Хи-квадрат	11,136
df	30
Meaningful/Значимость	0,000

Accordingly, the significance of Kendall coefficient sampling (KMO=7,25) and chi-square test (11,136) was confirmed at the level of (0,000) (Table 3) When Kendall's coefficient value is good and the chi-square test is significant, the correlation matrix is good for factor analysis. In the following, data related to mean and standard deviation and minimum and background of components will be presented.

Table 4. *Group of factors – components of the innovation system: Delphi data analysis results (n=26)*
Таблица 4. *Группа факторов – компоненты инновационной системы: результаты анализа данных методом Delphi (n=26)*

No Номер	Subgroup Подгруппа	Proposed components Предлагаемые компоненты	Min Мин	Max Макс	Average of results Среднее значение результатов	Standard deviation Стандартное отклонение
1	Individual factors Индивидуальные факторы	Courage Смелость	300	500	41154	0,43146
2		Tolerance of ambiguity Терпимость к двусмысленности	300	500	42308	0,71036
3		Risk-taking Принятие риска	300	500	42308	0,71036
4		Independence Независимость	400	500	43846	0,49614
5		Self confidence Уверенность в себе	300	500	40000	0,69282
6		Control focus Локус контроля	300	500	42308	0,71036
7		Motivation Мотивация	300	500	41154	0,43146
8		Perseverance Усидчивость	400	500	44615	0,50839
9	Organizational factors Организационные факторы	Structural Структурные	300	500	44615	0,64689
10		Cultural Культурный	300	500	42692	0,66679
11		Human resources Человеческие ресурсы	300	500	42692	0,66679
12	Environmental factors	Competition Соревнование	300	500	41154	0,43146

13	Средовые факторы	Suitable economic conditions Подходящие экономические условия	400	500	44615	0,50839
14		Organizational dynamics Организационная динамика	300	500	44615	0,64689
15		Technology infrastructure Технологическая инфраструктура	300	500	43846	0,49614
16		Customer attention Внимание клиентов	300	500	4000	0,69282
17		Technology complexity Сложность технологии	300	500	42308	0,71036
18	Material factors Материальные факторы	Fear of losing revenue Страх потерять доход	300	500	44615	0,43146
19		Reduction of investment incentives Снижение инвестиционных стимулов	400	500	41154	0,50839
20		Fear of being abandoned Страх быть брошенным	300	500	41154	0,43146
21		Cost of losing employees Стоимость потери сотрудников	300	500	42308	0,71036

The four factors explored, which have a total of 21 components, along with the mean, minimum, maximum and standard deviation of each item, are shown in Table 4. Four factors obtained respectively (individual factors, organizational, environmental and material factors) are listed according to the fields in which the questions are assessed.

Table 5. *Average of results*
Таблица 5. *Среднее значение результатов*

Group of factors Группа факторов	Subgroup Подгруппа	Components Компоненты	Average of results Среднее значение результатов
Innovation system components Компоненты инновационной системы	Individual factors Индивидуальные факторы	Courage Смелость	10,06
		Tolerance of ambiguity Терпимость к двусмысленности	10,06
		Risk-taking Принятие риска	11,38
		Independence Независимость	13,08
		Self confidence Уверенность в себе	8,94

		Control focus Локус контроля	11,38
		Motivation Мотивация	13,92
		Perseverance Усидчивость	13,92
	Organizational factors Организационные факторы	Structural Структурные	11,81
		Cultural Культурный	11,81
		Human resources Человеческие ресурсы	11,38
	Environmental factors Средовые факторы	Competition Соревнование	10,06
		Suitable economic conditions Подходящие экономические условия	13,92
		Organizational dynamics Организационная динамика	13,92
		Technology infrastructure Технологическая инфраструктура	13,08
		Customer attention Внимание клиентов	8,94
		Technology complexity Сложность технологии	11,38
	Material factors Материальные факторы	Fear of losing revenue Страх потерять доход	10,06
		Reduction of investment incentives Снижение инвестиционных стимулов	13,92
		Fear of being abandoned Страх быть брошенным	10,06
		Cost of losing employees Стоимость потери сотрудников	11,38

As the data of Table 5 shows, the components of each of the four factors measured are ranked (the rank of each component is between 7 and 14). The minimum rank – 8,94 – is obtained for the component of self-confidence from the «individual factors» subgroup and the component of customer attention from the «environmental factors» subgroup. The maximum rank – 13,92 – is obtained for structural components of «organizational factors» subgroup, the component of perseverance in the «individual factors», suitable economic conditions and organizational dynamics of «environmental factors» subgroup and reduction of investment incentives in «material factors» subgroup.

The data standardization method was used in the regression analysis in SPSS24 to edit the data of this study. The data values in the range of +3 to –3 were used with the values higher and lower than this range deleted from the data to provide the researcher with more standardized data for analysis. None of 21 items were removed and all items were included in the analysis. As it is shown in Table 6, the four factors are explored in the model structure of innovation systems for the sustainability of fields, each of the identified dimensions has sufficient predictive power to examine the scale based on the model design.

Table 6. *Matrix of research tool components*
Таблица 6. *Матрица компонентов исследовательского инструмента*

Фактор Factor	Material Материальный			Organizational Организационный			Environmental Средовый			Individual Индивидуальный		
Material Материальный	1000			0,822	1,442	2,080	0,493	0,832	1,913	0,306	0,405	0,693
Organizational factor Организационный	0,481	0,693	1,216	1000				1,326	2,080	1,710	2,759	3,557
Environmental Средовый	0,523	1,216	2,027	0,481	0,754	1000				0,281	0,362	0,585
Individual Индивидуальный	1,442	2,466	3,271	0,281	0,362	0,585	1,710	2,759	3,557	1000		
Total/Итого	3,446	5,376	7,515	2,584	3,559	4,665	4,203	5,907	8,550	3,297	4,527	5,836

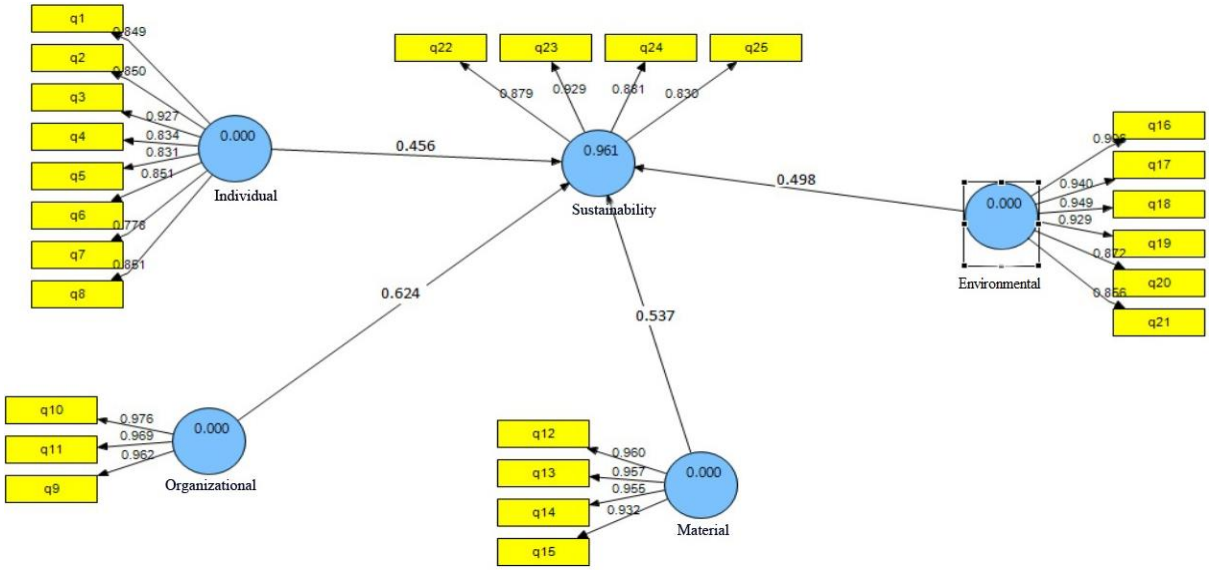

Fig. 1. *Conceptual model path of research in standard estimation mode*
Рис. 1. *Концептуальная модель в стандартном режиме оценки*

As it is shown in Fig. 1, the factor load for each of the metrics corresponding to the research variables is greater than the experimental value 4, that is why the metrics were correctly assigned to the evaluated factors. The absolute magnitude of significant statistics that have a t-student distribution was considered to evaluate the significance of the coefficients obtained in the model. The findings of this statistic in the research model are shown in Fig. 2.

According to the significant test statistics in Fig. 2, these values are larger than the critical one of the t-student distribution table, which is approximately equal to 1,96. Therefore, it can be concluded that the estimated relationships between the main variables and the estimated factor loads and between the latent variables and the observed ones were significant at the error level of 0,05. According to the significant test statistics obtained for the estimated factor loads, it is given that their values are larger than the critical one of the t-student distribution table. It can be concluded that each of the marker variables explain these components significantly to measure the latent components of the research.

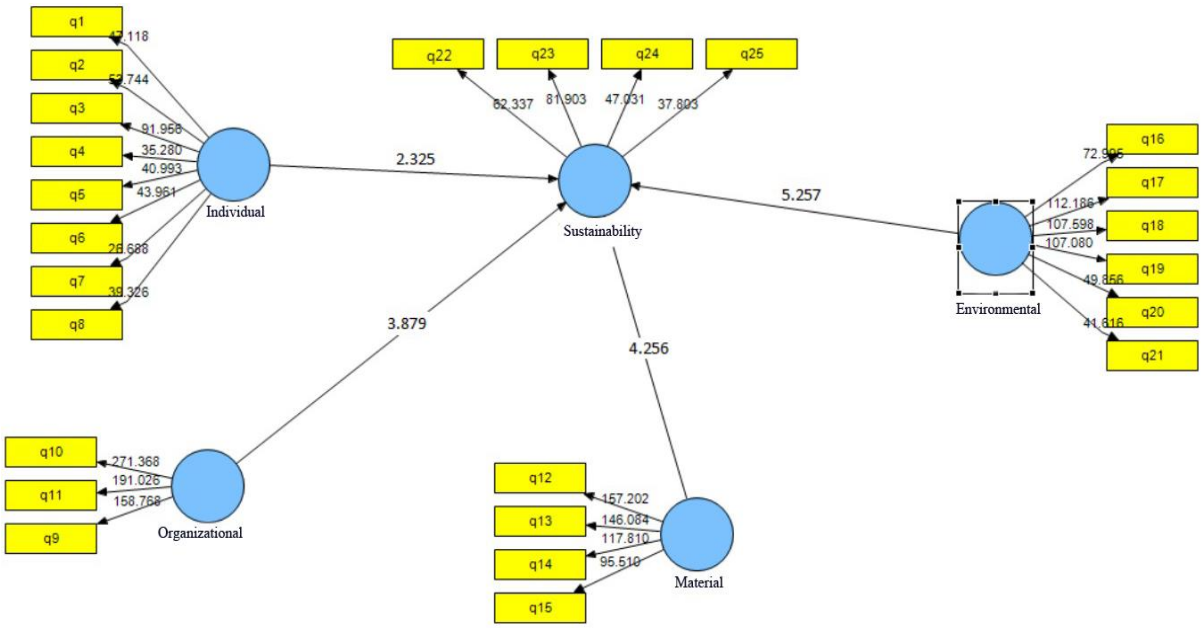

Fig. 2. *Path analysis of the conceptual model of research in the case of significant numbers*
Рис. 2. *Концептуальная модель исследования в случае значимых чисел*

Conclusion

This study was conducted to design a model of innovation systems for regional sustainability. In the first round, the panel members extracted the factors and components of the innovation system through the method of library studies, which involved a literature review and research background. In total, the factors and components were identified. They recognized the significance of each step with a high average of 4, which had very high influence. Moreover, the respondents mentioned a total of 4 factors for the innovation system and 21 components for the innovation system. As these factors were moderately identical to those shown in earlier study, they were removed and, in some cases, combined or replaced with current dimensions. In the second round, panel members repeated their views on the factors and components of the system, as well as the influence and significance of each of the factors and components. In this study, the Delphi method was performed in two rounds. The standard deviation of the panel members' responses in the first round was calculated about the importance of the factors. Furthermore, the value of the Kendall coefficient for measuring the degree of expert's consensus in the first round was 0,638 for innovation system factors and 0,451 for innovation system components. The value of the Kendall coefficient is the amount of agreement and consensus related to experts in the second round that achieved 0,725 for the innovation system factors, 0,747 – for the innovation system components, which proves that there is coordination between the views. Significance was also calculated to be 0,000, which symbolizes that the observed coordination coefficient is significant. The fuzzy hierarchical analysis technique was used to rank the factors. The results of the fuzzy hierarchical analysis revealed as well that the most important factors of innovation systems for the sustainability of regions for food industry companies are: individual factors, organizational factors, material factors, and environmental factors, respectively. The results of the fuzzy hierarchical analysis also confirmed that the most important individual factors of innovation systems are: motivation, courage, perseverance and endurance, independence, control center, ambiguity tolerance, self-confidence, and risk-taking. Additionally, the most important organizational factors of innovation systems are: human, structural and cultural resources, respectively. The most important

material factors of innovation systems are: cost of losing employees, fear of losing revenue, reduced investment incentives, and fear of being abandoned, respectively. Ultimately, the most important environmental factors of innovation systems are: technology complexity, customer attention, technology infrastructure, competitive environment, appropriate economic conditions, and organizational dynamics, respectively.

The effects of individual factors of innovation systems on the sustainability of regions were investigated, the results show that the path coefficient obtained is equal to 0,456, and the T-value is 2,325, so it can be concluded that the individual factors of innovation systems have a significant effect on the sustainability of regions. In examining the effects of the organizational factors of innovation systems on the sustainability of regions, the path coefficient equal to 0,624 is obtained, and the T-value is 3,879. Therefore, it can be concluded that the organizational factors of innovation systems have a significant effect on the sustainability of regions. In examining the effects of material factors of innovation systems on the stability of regions, the path coefficient equal to 0,537 is obtained and the T-value is 4,256, so it can be concluded that the material factors of innovation systems have a significant effect on regional stability. In investigating the effects of variable environmental factors of innovation systems on the sustainability of regions, the path coefficient equal to 0,498 is obtained and the T-value is 5,257. Therefore, it can be concluded that the environmental factors of innovation systems have a significant effect on the sustainability of regions. Since the mean criterion of variance extracted for the research variables is above 0,5, so the acceptable convergent validity and the AVE root of all structures are greater than their correlation coefficient, so the structures have divergent validity. According to the results of this study, the conceptual model of the research has a suitable fit. The study is compatible with the research model. Therefore, the proposed model is approved and all defined relationships are validated.

It is given that the mean criterion of variance extracted for the research variables is above 0,5, so the convergent validity is acceptable and the AVE root of all structures is greater than their correlation coefficient, so the structures have divergent validity. According to the results of this study, the conceptual model of the research has a good fitness.

As a result, according to the structural model and the goodness-of-fit indicators of the model, which are examined, the data collected from the sample are consistent with the research model. Therefore, the proposed model and all defined relationships are confirmed.

Suggestions

It is suggested that the food industry managers strengthen perceptual, human/communication and executive skills. Food industry managers should make their best effort to strengthen their capabilities in the field of coaching, change management, creative thinking and effective interaction skills in order to optimize the result of teamwork and networking continuously while having a service spirit and morality in adherence to human values. Food industry managers must have the necessary ability to meet the needs of customers; increasing the quality of activities is one of the ways to meet environmental requirements. Improving the quality of activities requires the use of a credible system for evaluation and reward. Objective- and subjective-based criteria evaluation enables managers to identify their strengths and weaknesses and strive to develop the food industry. It is suggested to food industry managers to strengthen sufficient strategic knowledge about strategic planning in the field of treatment and commitment to continuous learning and up-to-date specialized knowledge among medical staff managers. It is recommended that meetings should be held with the presence of senior managers of the organization to strengthen the knowledge dimension. Decisions such as in-service training, devoting hours of the day to study and encourag-

ing personnel to learn should be taken into account to strengthen this dimension. Suitable contexts should be provided to increase general knowledge by participating in training courses, topics of knowledge sharing methods and integration of knowledge and the benefits of these courses. In the field of knowledge management, the knowledge of the organization will undoubtedly be lost if knowledge is monopolized by the people of the organization by leaving prominent people in it. Thus, organizations can be protected from vulnerability if they make their efforts to organize their knowledge.

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МОДЕЛИРОВАНИЕ СЕКТОРАЛЬНЫХ ИННОВАЦИОННЫХ СИСТЕМ В ИНТЕРЕСАХ УСТОЙЧИВОГО РАЗВИТИЯ (НА ПРИМЕРЕ ПИЩЕВОЙ ПРОМЫШЛЕННОСТИ ИРАНА)

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Актуальность. *В настоящее время в литературе по исследованию регионального измерения инновационных систем особое внимание уделяется динамике развития регионов и территорий, а также устойчивости этих инновационных систем. Данное исследование направлено на разработку модели региональной инновационной системы в целях обеспечения устойчивости развития пищевой промышленности компаний Ирана. Предложенная модель разработана на основе собранных данных по литературным и эмпирическим источникам в ходе проведения интервью с экспертами. Эта модель в дальнейшем может быть использована менеджерами в качестве инструмента для стратегического планирования и прогнозирования будущего развития пищевой промышленности Ирана.* ***Цель.*** *Основная цель исследования – разработка модели инновационной системы, объясняющей факторы устойчивости компаний пищевой отрасли в Иране. Авторы анализируют концепцию региональных инновационных систем применительно к пищевой промышленности Ирана, определяют факторы, которые влияют на устойчивость пищевой отрасли в региональных инновационных системах Ирана, а также приоритизируют эти факторы и оценивают влияние этих факторов на устойчивость инновационной системы.* ***Методы.*** *Анализ и синтез, FUZZY, Delphi, FAHP.* ***Выводы.*** *Факторы, которые влияют на инновационные систем и их устойчивость, были определены на основе изучения литературы, а также интервью с профессорами и экспертами в области маркетинга и применения метода Дельфи. Приоритет и значимость каждого из этих факторов были оценены с использованием методов нечеткого иерархического анализа после разработки и распространения анкеты среди экспертов пищевой промышленности. Результаты нечеткого иерархического анализа дополнительно показали, что наиболее значимыми факторами для поддержания устойчивости инновационной системы в интересах компаний пищевой промышленности являются: индивидуальные факторы, организационные факторы, материальные факторы и факторы окружающей среды соответственно. Результаты нечеткого иерархического анализа дополнительно пояснили, что наиболее значимыми индивидуальными факторами инновационных систем являются: мотивация, смелость, упорство и настойчивость, независимость, контроль, толе-*

рантность к двусмысленности, уверенность в себе и принятие риска. Кроме того, наиболее важными организационными факторами инновационных систем являются: человеческие, структурные и культурные ресурсы соответственно. Наиболее существенными материальными факторами в инновационных системах являются: большие затраты при выходе инвестиций, страх потерять прибыль, снижение инвестиционных стимулов и страх быть брошенным, соответственно. Наиболее важными факторами окружающей среды инновационных систем являются: технологическая сложность, внимание к потребителю, технологическая инфраструктура, конкурентная атмосфера, подходящие экономические условия и организационная динамика, соответственно. В соответствии с полученными результатами по достоверности и надежности разработанная модель инновационных систем в интересах оценки региональной устойчивости может быть использована в прикладных и практических исследованиях.

Ключевые слова: *Модель инноваций, инновации, инновационная система, устойчивость, устойчивость регионов.*

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