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Presenting a Model for the use of the Internet of Things in the Iranian Knowledge-based Companies

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Abstract

The purpose of the present study is to present a model for the use of the Internet of Things in Iranian knowledge-based companies. From a purpose point of view, this research can be classified as applied research and in terms of data collection, it can be categorized as a qualitative and quantitative study. The main approach for achieving the model of using the Internet of Things is the grounded theory methodology which is based on a paradigmatic model. The research population for the qualitative phase is comprised of 25 executives and practitioners of knowledge-based companies who are somehow specialized in Internet of Things topics. The sample of this study was selected using the snowball sampling method and Cochran's formula for finite communities among all the managers and technology experts working in knowledge-based companies. After careful analysis of the interviews, 59 extracted concepts were identified in 5 main categories and 13 subcategories. Management requirements, customer requirements, and resistance economics give rise to the Internet of Things in knowledge-based companies. The characteristics of the company, the characteristics of the human resources and the characteristics of the managers can provide a suitable ground for using the Internet of Things. And the conditions in the country, international pressures and international cooperation can be among the intermediary factors influencing the use of the Internet of Things. Raw materials and infrastructure can also be effective strategies for using the Internet of Things. Using the Internet of Things, customer-related factors, international collaborations, and expected results can be expected in knowledge-based companies.

Keywords: Internet of Things, Knowledge-Based Companies, Grounded Theory

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Introduction

The ever-increasing extension of information and the highlighted role of the Internet in human life has entailed new events and imposed some major shifts in the process of doing things. The interaction between objects through sensors and labels has built a network of objects which subsequently lead to bringing connection and interaction of them at any time and anywhere. As a result, a concept so-called the *"Internet of Things"* (IOT) was formulated and a wide range of new potential products and services were created within different domains. Initially coined by Kevin Ashton, the Internet of things (IOT) described a world in which everything, including inanimate objects, has its own independent digital identities which are managed and organized by computers (Zaki, 2016).

The Internet of Things (IOT) as a novel concept is the manifestation of a future when physical objects connect to the Internet and make interactions with other things. This concept has been attached special importance because objects will become more efficient and effective phenomena if the digital representation of them can be demonstrated (Yousefi Pourjadi & Haghshenas, 2016). IOT has imposed itself on various domains and it is gradually being recognized. Today, researchers in different areas show a growing tendency to application of the IOT. One of these domains is knowledge-based companies because a large portion of the IOT use in the future will be associated with the technology-based business operations to do the usual affairs of a business. The IOT is likely to be considered as a driving force to continue and facilitate the growth and productivity of knowledge-based companies (Santoro et al., 2017).

Today, resorting to the rapid technological advance, intense global competition, and the constant changes in the consumers' tastes, the digital economy has imposed such increasing pressure on the commercial and industrial sectors that they have no choice but to adapt themselves to the existing conditions. They need to build information networks to remain competitive and keep track of their business activities. The major focus of these networks is on the joint development of strategic goals and the sharing of business costs and ventures, which led to the foundation of knowledge-based companies (Amini, Mir Mohammadi & Qesa, 2015).

Knowledge-based companies are types of private or cooperative institutions founded with high-added value to realize the synergy of science and wealth, develop a knowledge-based economy, achieve scientific and economic goals, including the expansion and application of invention and innovation, as well as commercialize the research findings and they progress in the field of technology and added value (Ahmadi Joushoghani, 2016).

Knowledge-based companies work by creating knowledge and innovation to formulate value in a competitive environment (Bazargani and Fathi, 2018).

It is claimed that the IOT plays a crucial role in the prediction of organizational performance in knowledge-based companies through accomplishing such functions as a periodic and continuous collection of customers' information and specific parameters related to each product; provision of constant tracking and monitoring, offering remote access services, developing information management, sending an intelligent content to the audience, inter-organizational integration, and environmental activity (Hendrix, 2016). As an emerging trend in information technology, the Internet of Things (IOT) has not only held a special place in the knowledge-based sector but come into a variety of uses and applications in the world, so that it will lead to such positive consequences as lowering the escalating costs of production and increasing customer satisfaction (Karimova, 2015).

In spite of the high potential of this technology, it was ignored in Iran's industry and organization. According to the published report by Islamic Parliament Research Center (IPRC), Iran is the 20th country taking benefit of this technology and has the large capacity to expand its implications in different domains. Due to the worldwide extension of IOT and recognition of its significance, Iranian organizations should also enjoy the benefits of this technology to maximize their effectiveness and efficiency (Zargar, 2019).

On the other hand, in recent years, the sanctions imposed against Iran by Western countries have had a negative and destructive effect on the economic structures and indices of the country. The knowledge-based companies resorting to their special features; dynamic and flexible nature, as well as the high capacity to make environmental adaptations, are potentially capable of coping with these sanctions. The higher capability of these companies compared to their traditional counterparts has resulted in a substantial increase in productivity and efficiency. Further, decentralization of activities immune their products or raw materials from being easily subjected to sanctions (Ahmadi Joshoughani & Ismailian, 2016).

Taking these into account, the application of the IOT seems to be a necessity in knowledge-based companies. Although the IOT is in its infancy and early stages of approval and acceptance, the role of this technology is increasingly expanding in daily lives. Like any other new technology, there might be some challenges and obstacles with respect to the deployment and implementation of the IOT (Zargar, 2019). The obstacles can result from such challenges as standardizing the IOT products, devices, and applications, providing constant monitoring, undertaking technology transfer and update, as well as ensuring network security (Ghasemi et al., 2016). There might exist a set of standards, frameworks or models which can minimize these deficiencies. Until now, there has not been proposed any model and framework for IOT use in knowledge-based companies.

Accordingly, it is highly necessary to present a model for the application of the IOT in these companies. The findings of the current study offer some implications in the sense that after modeling, the indices associated with the consequences, resources, and challenges and reasons for using IOT, will be extracted and considered as the basis for further research in this respect. Further, the findings of the present study can help knowledge-based companies to be much more aware of the strengths and weaknesses of IOT use and, use the results of this awareness to make appropriate planning and decisions concerning the management of IOT. This study is intended primarily to present a model of using IOT in Iranian knowledge-based companies through adopting ground theory methods.

Background

A review of the existing literature suggested that despite the ever-growing significance of the IOT, this technology has not been paid any attention in Iranian knowledge-based companies. Therefore, the related literature on knowledge-based companies and the IOT were reviewed separately.

Studies in the field of Knowledge-based Companies

Jalalpour, Talebi and Taybi (2016) in a study investigated the factors affecting policies and executive programs which can improve the performance of Iranian knowledge-based companies. The results identified a set of factors including the institutional, financial, market, cultural, human, networking, informational, social-environment, geographical-environment, international relations and physical infrastructure factors that exist in policies and executive programs that affecting KBFs performance.

In the same vein, Khayatian, Eliassy and Tabatabayan (2016) conducted a research work entitled "Sustainability Model of Knowledge-Based Companies in Iran". The findings revealed that the nature of sustainability of knowledge-based companies consists of four components: financial results, market results, innovation results and entrepreneurship results.

Daneshfard (2016) tried to identify the effective factors on the deployment strategy of knowledge-based companies. He utilized Russ et al (2010) 6-factors model as the basis of research, and the Delphi technique and opinions of experts were used for localization. As the result, finally, a 6-factor model with 24 indices was presented. Rezaei and Vosoughi (2017) in another study focused on the role of knowledge-based companies and science and technology parks in the realization of resistance economy.

Arman and Shafiei (2018) investigated the impact of strategic agility and strategic learning on competitive capabilities in knowledge-based firms and found that both factors have positive and significant effects in this regard. Bazargani and Fathi (2018) in their study present a method to design a strategy map using the concept of "House of Strategy" and Fuzzy Copras in a knowledge-based company. The main purpose of the strategy map is to make a cause-effect relationship between strategic goals and the translation of these objectives into operational programs.

Mansoori, Vazifeh and Yoosefi Tabas (2018) conducted an investigation entitled “prioritizing the effective factors in the development of knowledge-based companies” in which they ranked these factors in the following order: factors effective in establishment and development of technology-based centers, socio-cultural factors, human resources factors, supportive factors affecting knowledge-based institutions in producing technologies, governmental and infrastructural factors. Rostami and Vazifehdoost (2019) conducted a study to determine the interrelationship between open innovation, strategy innovation and gaining competitive advantage in knowledge-based companies. They found there is a significantly positive relationship between these variables.

Studies in the field of IOT

Vahdat, Shams and Nazemi (2018) examined the features and benefits of the architecture of the device-dependent temporary services, and a method for implementing the virtual object of bus tickets as a case study based on it. The results show that the benefits of virtualization of bus tickets in the process of utilizing the relevant services are more valuable than other solutions

Oyewobi, Hancke, Abu-Mahfouz and Onumanyi (2019) conducted a study to clarify a dynamic spectrum access (DSA) technique that will ensure fair allocation of the available network resources for diverse network elements competing for the network resources. In this work, two reinforcement learning (RL) algorithms are integrated into the CSS to perform channel selection. The findings showed a significant reduction in terms of latency and a remarkable improvement in throughput performance in comparison to conventional approaches. Özdemir (2019) in his study offered an analysis of how digital health innovations are being co-produced by mainstreaming of artificial intelligence (AI), the Internet of Things (IoT), and cyber-physical systems (CPS) in health care. He concluded that it is highly critical for the system sciences and integrative biology communities to pay more attention to digital health and related technologies such as AI, IoT, and CPS.

Tan et al. (2019) in their study provide a model for using the Internet of Things in an underground mine. The findings revealed that the availability of high-speed Internet, costs of manpower and managers' knowledge are effective factors in using the IoT. In a similar vein, Suresh et al (2019) present a model for using the IoT in environmental monitoring and demonstrated that the existence of infrastructure, experience and knowledge concerning the benefits of IoT, as well as high speed of the Internet are the effective factors that encourage the use of IoT in environmental monitoring.

Pursuing the same line, Shi et al. (2019) investigated the use of the IoT in agriculture. Innovative ideas and technological advances make great contributions to the agricultural industry in boosting production and optimizing allocated resources. Today, the IoT is used to produce more agricultural products with lower costs and efficient use of resources. In another study, Qasem et al. (2019) carried out research work to investigate the use of IoT in water treatment and found that the application of this technology can lower the costs to a great extent. Nespoli et al. (2019) conducted a study entitled "Collaborative, Seamless and Adaptive Sentinel for the

Internet of Things”. Qu et al. (2019), in their study, addressed the application of the IoT in the realm of Health Management and showed making benefits of this new technology in the health sector can minimize the wasting of cost and time.

Alam (2020) investigated challenges and difficulties related to security, reliability, privacy and availability of services from the Cloud point of view. He tried in this study to build a mobile ad hoc network mobility model framework using cloud computing to provide secure Internet of Things communication between smart devices. This research would create new connectivity architecture to address the problem of secure communication between smart devices in5G networking.

The literature suggested that the effectiveness of using IoT has been investigated in a large number of areas such as health management (Qu et al., 2019); health sector (Ozdemir, 2019); water treatment (Qasem et al, 2019); agriculture (Shi et al., 2019); mining (Tan et al., 2019); industry (Oyewobi et al., 2019); and environmental monitoring (Suresh, 2019); however, there appeared to be very few studies in which the use of IoT has been explored in the context of knowledge-based companies.

Furthermore, the review of the literature in terms of methodology showed that a large portion of previous research works in this field were conducted adopting either quantitative or qualitative design and the dominant data collection tools in these studies were interviews or questionnaires. Due to the novelty of this field and its infancy in knowledge-based companies, there is a need for adopting mixed-method design in future inquiries to get a much better and profound understanding of this concept. Therefore, in this study, there is an attempt to present a more comprehensive model in which besides all the indices mentioned in the above research, other indices in the form of five core components including causal, contextual, and environmental conditions, as well as strategies, and outcomes have been clarified.

Table 1. IoT applications in different industries

	Authors	**IoT applications in different industries**
1	Alam, 2020	smart devices in5G networking
2	Qu et al., 2019	health management
3	Suresh, 2019	environmental monitoring
4	Qasem et al, 2019	water treatment
5	Ozdemir, 2019	health sector
6	Tan et al., 2019	Underground Mining
7	Shi et al., 2019	Agriculture
8	Oyewobi et al., 2019	industry

Methdology

In the present study, a mixed-method design has been adopted in which the first phase was carried out qualitatively through the grounded theory method leading to the presentation of a new model. The second phase was devoted to the validation of the proposed model by the qualitative section using a survey.

Since the major purpose of this research is to present a model of using the IoT in knowledge-based companies, it is an emergent need to investigate different aspects of this challenging task. Resorting to this necessity, the grounded theory method was adopted in this study. Grounded theory is appropriate for generating and refining theories or models (Chun Tie et al., 2019). Also, the grounded theory is a suitable method for qualitative researchers to answer questions like “what is going on in an area?” by generating formal or substantive theory (Strauss & Corbin, 1997).

The required data for the present study was collected using interviews and observation, as well as holding a brief conversation with some staff of the targeted companies. The first interview was conducted in an unstructured (non-directive) manner with completely open-ended questions. However, as the interview proceeds, taking the respondents' answers; the coding of the initial interviews and discovered clues of the previous questions, a small change was done to shift the form of these questions. Although all questions were relevant to the topic and compatible with the framework of the main questions of the study. At the end of each interview, the researcher, using his perception, retold the content expressed by the interviewee once again to ensure the accuracy of the content after the interviewee confirms it. In addition, the length of each interview was between 30 to 45 minutes, depending on the parties’ agreement and organizational conditions. After extracting the results and designing the model, a measurement scale was validated and constructed concerning the use of IoT in knowledge-based companies.

The research population for the qualitative phase of the study includes all experts and scholars in the realm of IoT who possess any working experience in knowledge-based companies. Thus, using the snowball sampling method, several people were selected from this population for interviews. In the snowball sampling method, the sample units provide information not only about themselves but also about other units (Strauss & Corbin, 1997). Concerning the samples size of the study, it is noteworthy that the sampling was continued until the development of new conceptual insights. For the qualitative parts of the study, 25 participants were selected based on the following criteria: a) Being a managing director or expert in knowledge-based companies; b) Having a master's and PhD degree; c) Possessing at least 5 years of working experience in knowledge-based companies.

In the quantitative phase of this study, the population consists of all managers and technology experts in knowledge-based companies. In order to identify the sample size, Cochran's formula was used and the sample size was found to be 400. The sampling was carried out using the multi-stage cluster method. The first seven provinces were selected and then all knowledge-based companies involved in the realm of IoT located in these provinces were identified. The selected provinces included Tehran, Kerman, Markazi, Bushehr, Tabirir, Hamedan and Zahedan.

To assess the reliability of this study, all the considerations concerning the credibility of the current research work have been given, through a long-term presence in the research environment, spending more time with participants, exchanging views with professors and experts about the data, collecting and storing raw data and use them after reviewing the findings to evaluate the interpretations. To do so, the researcher exchanged views and received feedback from three experts in the university and three of the participants. Concerning generalizability, the research context and conditions have been described which encompasses the geographical location of the research, and the features and number of the participants. Regarding reliability, by creating an audit guide by recording interviews, preparing an interview handbook, a list of interviewees, and finally the categories obtained from open coding are reasonably related to each other.

Concerning the validity of the study, the obtained data were corresponded with the pieces of evidence and sources in the research literature and also in some cases the participants were asked about the accuracy of the claims of others and finally the views and opinions of other experts were used. To evaluate the importance of each factor extracted from the qualitative part of the study, a 5-point Likert scale questionnaire was constructed. According to the statistical analyses, the internal consistency coefficient (Cronbach's alpha) of the subscales of the background, mediating conditions, strategies, causal conditions and consequences were found to be 0.83, 0.91, 0.92, 0.83 and 0.85, respectively. And the internal consistency of the whole questionnaire was turned to be 0.87. To determine the validity of the factors and sub-categories of the scale, the principal component analysis method with varimax rotation was used. Also, confirmatory factor analysis was used to determine the factor validity and the results revealed that the structure of the questionnaire has a satisfactory fit with the data and all the model fit indices are acceptable. To evaluate the concurrent validity, the IoT scale designed by Tavakoli, Razzaqi Shirsavar and Nasiripour (2017) was used.

The Results of Qualitative Part

Due to the nature of the research design in this study and the simultaneous use of quantitative and qualitative methods, the obtained data were not demonstrated either descriptively and inferentially but were based on the research process (first the findings of the qualitative and then quantitative).

To achieve the primary model of using IoT in knowledge-based companies, the grounded theory method was adopted, which includes open coding, axial coding and selective coding stages. At the initial stage, the categories are identified through open coding, and during axial coding, the categories are associated with each other, and then through selective coding, categories, subcategories and their relationship are integrated to develop a theoretical model.

Open coding: At this stage, the interviews were transcribed and subjected to thematic content analysis. Each of transcribed interviews was read carefully line by line to identify the discrete event and each determined theme was given code. Thus, for all interviews, the initial codes were separately extracted. After that, the determining codes were checked for similarities between them. Similar codes to create concepts and form categories went together under one category.

Since there is not any constraint on naming concepts at this stage, the number of codes is usually large. Findings from open coding were tabulated, and due to the length of the table, only the first few lines of them are illustrated.

Axial coding: Axial coding is the process of linking categories to subcategories. The purpose of this step is to establish a relationship between the generated codes (resulting from open coding). Thus, at this stage of the analysis, using the analytical hierarchy process the factors are categorized into main factors and sub-factors. Subcategories give more explanation to the main factors (Strauss & Corbin, 1997). In this stage of classification, in addition to paying attention to the common characteristics, the codes were tried to be based on the conditions, actions and reactions (strategies) and the results around the common axis, in other words, information Connect by establishing links between categories.

Table 2. Open Coding

Category	Conceptualization	responder	A sample of sentences extracted from the interview
Management requirements	Previous experiences	P24	I had previous experience working with the Internet of Things. So I decided to use it in this company as well.
		P3	In the company I used to work for, the Internet of Things was used. This encouraged me to use it.
	Strategic plans	P13	In the programs that I prepared for the company, the use of these types of innovations was considered.
		P3	The use of the Internet of Things is part of the company's programs that are being used.
		P9	Every company has its own strategies, we also had our own strategies based on which we need to use the Internet of Things.
Customer requirements	Increasing customer expectations	P20	One of the requirements that have forced us to use the Internet of Things has been the high level of expectations of our customers.
		P21	We had to use the Internet of Things to meet the expectations of our customers.
	Competitive products	P25	The quality of our product was lower than the competitors. We used the Internet of Things to increase product quality.

Selective coding: In the selective coding stage, after several times of moving back and forth between codes and data, concepts and categories, one of the categories are selected as the core concept around which the other categories from the Axial Coding phase are grouped. At this stage, there is an attempt to establish logical and systematic links between the categories generated in the previous stages, to confirm the connections between the categories derived from the open and axial coding stage through a narrative description.

Using the selective coding method and the central concept, the findings were interpreted. The grounded for interpretation of the obtained results was provided by describing the findings narratively. Finally, after the end of the qualitative part of the study, the five main categories of the primary model were identified as follows:

1. **Causal conditions:** They are a set of conditions that cause the emergence and development of the phenomenon (main category). Among the existing categories, those related to this factor were identified as follows:

- **Management requirements:** This category suggests that previous experiences and strategic planning can affect the implementation of the IoT in Iranian knowledge-based companies.
- **Customer requirements:** Increasing customer expectations and enhancing the competitiveness of products can affect the use of the IoT in these companies.
- **Economic resilience:** Lack of resources and equipment, as well as unbalanced economic growth, can affect the use of the IoT in these companies.

2. **Contextual conditions:** They are the particular set of conditions within which the action/interactional strategies are taken concerning managing the core phenomenon. The context also includes the characteristics of the main category. Based on the findings of this research, the categories related to this concept are as follows:

- **Characteristics of the company:** This category indicates that the presence of a professional team, the existence of planning, foresight, quality control unit, financial wealth, commitment, sufficient knowledge, Resilience Company and teamwork can provide a good ground to the realization of IoT in knowledge-based companies.
- **Manpower Characteristics:** High cost of manpower, skilled, young, experienced, knowledgeable, creative, innovative and empathetic manpower, can pave the way to realize the use of IoT in these companies.
- **Characteristics of managers:** Experienced, negotiators, cooperative, flexible, risk-taking and up to date managers can facilitate the realization of the IoT in knowledge-based firms.

3. **Mediating conditions:** are the context of the broad structures in which the main category occurs and affect the way of reacting to its consequences. The categories related to this dimension were determined as follows:

- **Conditions governing in the country:** This category indicates that laws, traditional management, investment risk, inflation rate, lack of attention of scientific centers and exchange rates can be among the mediating factors affecting the realization of the use of IoT.
- **International pressures:** The impacts of sanctions, production of sanctioned goods, sanctions of parts, fluctuation of exchange rates can be among the mediating factors influencing the use of the IoT.

- **International cooperation:** Scientific cooperation and business cooperation by companies can be among the mediators which can influence the use of the IoT.

4. **Strategies:** In a context with specific mediating conditions, there will be the possibility of adopting a specific set of strategies or taking particular actions. The sub-categories related to this factor was identified as follows:

- **Raw materials:** Supplying raw materials, solving import problems and making raw materials cheaper can be considered as an effective strategy for using the Internet of Things.
- **Infrastructure:** Reducing the cost of the Internet, resolving antenna problems, improving Internet security, and expanding Internet infrastructures can be effective strategies in using the IoT

5. **Consequences:** refers to the consequences of realizing the central category in the context of causal, environmental and contextual conditions and through specific strategies. Sub-categories related to this concept were identified as follows:

- **Customer-related factors:** These factors pointed out that the realization of central category through the strategy mentioned in the previous step, provide a proper ground for improvement of the products quality and customer privacy, increasing perceived security by the customer, production based on customer demand, improving marketing methods, reducing organizational resistance in companies against the IoT, customer satisfaction and flexible production with technology in the knowledge-based companies.
- **International Cooperation:** This category pointed out that if the central category is realized through the strategy mentioned in the previous step, it is possible to use the Internet of Things to promote scientific and commercial cooperation in knowledge-based companies.
- **Expected results:** If the central category is realized through the strategy mentioned in the previous step, it is possible to use the Internet of Things to inform the customer, train employees, and reduce costs in knowledge-based companies.

The Findings of the Quantitative Phase: Performing Factor Analysis of IoT Questionnaire in Knowledge-Based Companies

After extracting the results of the qualitative section, a questionnaire was constructed to analyze the confirmatory factor and prepare the final model. After ensuring the content validity and examining the Bartlett and KMO index, the questionnaire underwent factor analysed using the principal components method and Varimax rotation by the means of SPSS and LISREL software. To determine whether all the items of the IoT questionnaire in knowledge-based companies are saturated with several significant factors, three main indices have been taken into account including a) Eigenvalue of factors; b) Explanation of variance ratio made by each factor; c) The rotating diagram of eigenvalues called scree. The Scree diagram shows a plot of the total variance explained by all principal components. In this diagram, the large factors are usually illustrated at the top and other factors are demonstrated together with a gradual slope. Experience suggests that scree invariably began at the kth latent root when k was the true number of factors

(SPSS, 1975). The findings show that the eigenvalues of the five factors are greater than one, among which the eigenvalue of the first factor (18.01) is not significantly different from the eigenvalues of other factors (the second, third, fourth and fifth factors have the eigenvalue of 10.52, 8.69, 5.73, 4.89; respectively. These five factors together explain 81.1 percent of the total variance between the 59 studied substances. Thus, if only five factors are extracted from the total questions, about 30.53 percent of the common variance between the questions is explained by the first factor. To identify the ultimate number of factors that need to be extracted in the final stage, a Scree plot was used. The Scree plot of this questionnaire is illustrated in Figure 1.

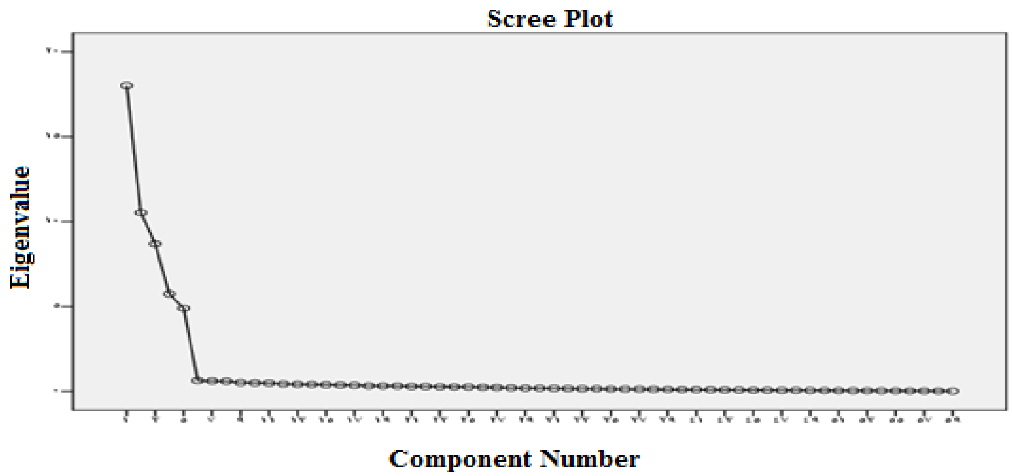

Figure 1. Scree diagram of 59 factors of IoT use the questionnaire in knowledge-based companies

Based on the Scree test and the eigenvalues of the factors, which clarified the approximate number of extracted factors, a maximum of three strong factors can be extracted. Factor analysis using the principal components method after ten times trial and error achieved the best composition of materials and its operating structure. Factor analysis by the inclined rotation method led to the extraction of six factors. In factor analysis, factor loading of at least 0.3 is used based on the extraction of 5 factors and 60 repetitions and to arrange factor loading greater than 0.3. However, some researchers concerning the relationship between variables and also achieving the definitions of factors considered coefficients higher than 0.3 and sometimes higher than 0.4 as significant and the coefficients lower than these as zero (Random factor). Undoubtedly, the higher the factor of an item, the greater will be its influence on determining the nature of the factor in question. In the present study, due to the length of the questionnaire, the minimum significant coefficient of 0.5 has been considered. Once the model has been determined, there are several ways to estimate whether the whole model fits with the observed data. Generally, several indices are used to measure the fit of the model, but usually, 3 to 5 indices are sufficient to confirm the model. The results of the factor analysis model related to the use of IoT are illustrated in Figure 2. As demonstrated in Figure 2, the factor loading of all items is greater than 0.5, and this confirms the result of factor analysis.

Table 3. Model Fitness Indicators in Structural Equations

index	2 /dfχ	RMSEA	GFI	RMR	CFI	NFI	NNFI
Measure	1.73	0.043	0.91	0.047	0.98	0.96	0.98
	<5	<0.1	>0.9	<0.5	>0.9	>0.9	>0.9

According to the values of the indices in Table 3, in the IoT model, the value of Chi-square is 1.73 which is less than 5, shows a good fit of the model. The value of the RMSEA index is 0.043 which is less than 0.1, which suggests that the model has a satisfactory fit. The values of GFI, RMR, CFI, NFI, NNFI indices also indicate the proper fit of the model. Finally, at the end of the qualitative and quantitative parts of the study, 5 main factors, 13 sub-factors and 59 concepts were extracted for the use IoT model in Iranian knowledge-based companies. Then, the categories were placed in the form of a paradigm model (causal and contextual conditions, main category, environmental conditions, strategies, consequences) (Figure 3).

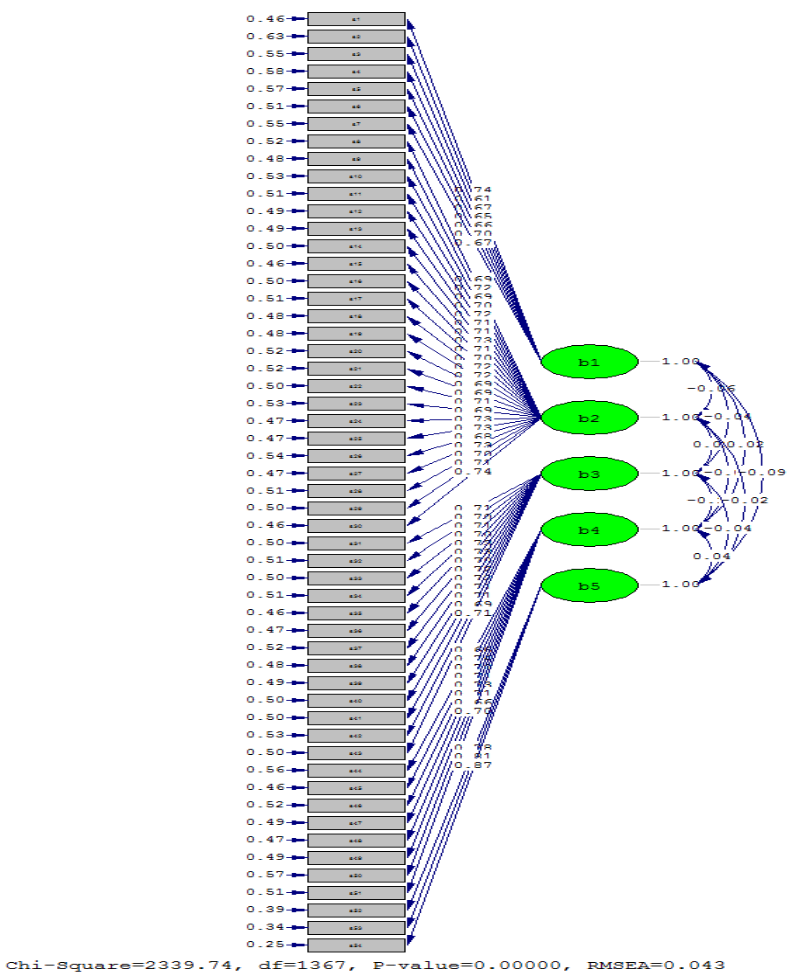

Figure 2. Factor analysis model related to the use of IoT

Discussion

The present study seems to be one of the few investigations in which an attempt has been undergone to design a model of using the IoT in knowledge-based companies by the means of the grounded theory method. It appeared to be no research works in this respect to be used as a comparison. However, the results of this study can be compared with previous investigations.

The results of the present study showed that managerial requirements (including previous experiences and strategic plans), customer requirements (including increasing customer expectations and competitiveness of products) and economic resilience (including limited resources and equipment and unbalanced economic growth) cause the emergence and development of the IoT in the knowledge-based companies. It was also found that factors such as the characteristics of the company (including the presence of a professional team, the existence of planning, foresight, the existence of a quality control unit, financial wealth, commitment, sufficient knowledge, economic resilience and teamwork), manpower characteristics (including high manpower costs, skilled, young, experienced, knowledgeable, creative, innovative and empathetic manpower) and managerial characteristics (including experienced, negotiator, cooperative, flexible, risk-taking and up to date managers) can provide the proper ground for the use of IoT in knowledge-based companies in Iran. Supporting these findings, a study by Shi et al (2019) showed that factors such as education and experience can be effective in using the IoT in agriculture. Tan et al. (2019) also believe that the availability of high-speed internet, high cost of manpower and knowledgeable managers can influence the use of the IoT.

Conditions governing the country (including laws, traditional management, sanctions, investment risk, inflation rate, lack of attention of scientific centers and exchange rates), international pressures (including the impact of sanctions, production of sanctioned goods, the effect of sanctions of parts on exchange rates) and international cooperation (including companies scientific and business cooperation) can be among the factors which mediate the use of the IoT. In their study, Amini, Mir Mohammadi and Qesa (2015) considered reducing the influence of international sanctions on the country in the realm of high-tech products in terms of absorbing and producing knowledge from the perspective of increasing the quality and quantity of output, as well as lowering costs and prices for the customer as the mediating factors in this regard.

Raw materials (including providing raw materials, solving import problems and cheaper raw materials) and infrastructure (including reducing the cost of the Internet, solving the problem of antennas, improving Internet security and expanding internet infrastructure) can be considered as an effective strategy in the use of IoT. A study by Suresh et al (2019) also indicated that the use of IoT requires infrastructure, experience and knowledge, as well as the benefits and high speed of the Internet, which leads to the much more efficient use of IoT in environmental monitoring. Pursuing the same line, Tan et al. (2019) also identified the availability of high-speed internet, the high cost of manpower as two effective factors on the use of IoT.

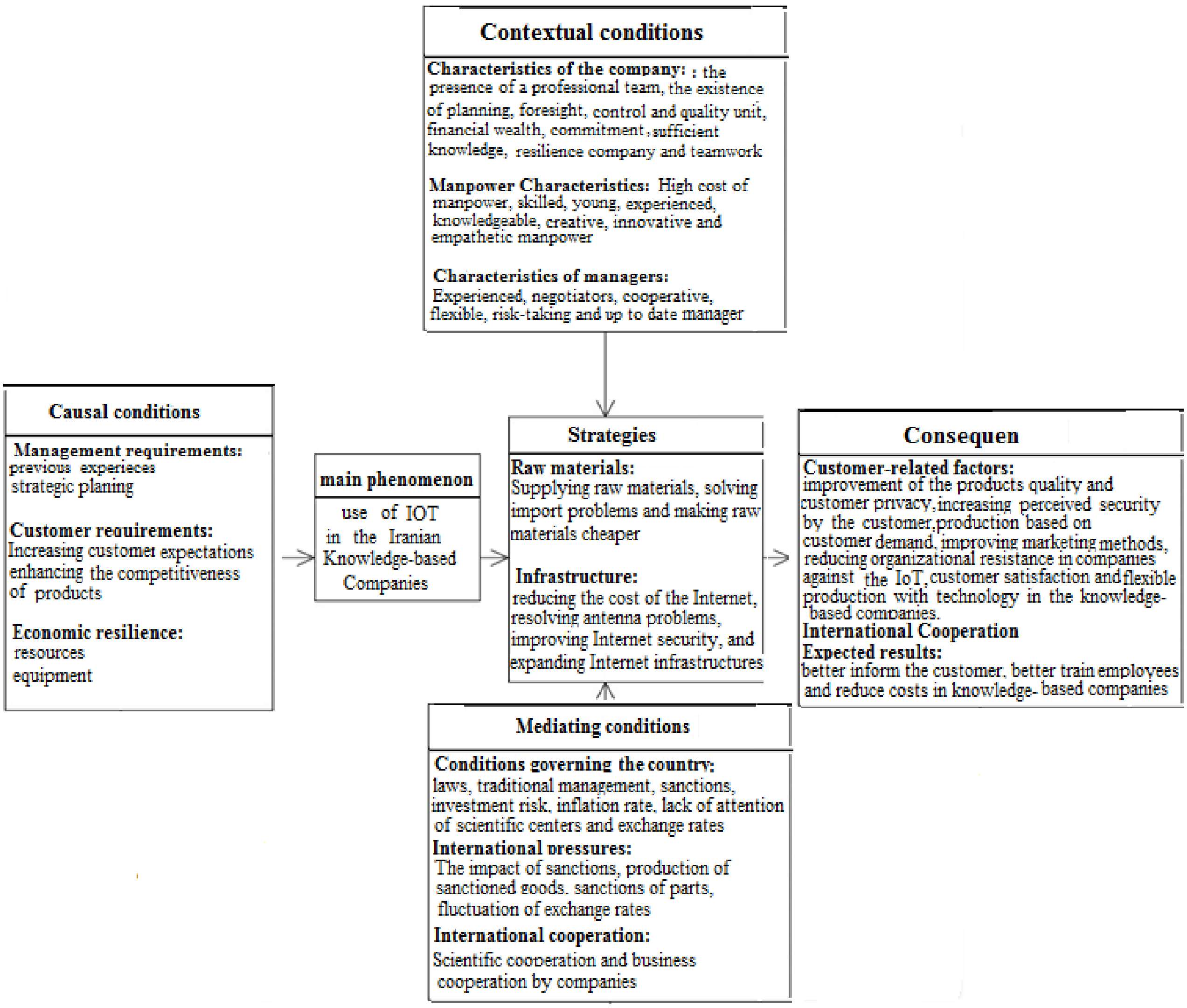

Figure 3. IoT use model in Iranian knowledge-based companies

Finally, the findings suggested that for the purpose of using IoT, customer-related factors (including improving product quality, customer privacy, increasing perceived security by the customer, production based on customer demand, method improvement), marketing (reducing corporate resistance to IoT, customer satisfaction, flexible manufacturing with technology), an international collaboration (including scientific and business collaboration), and expected results (including better awareness to the customer, better staff training and cost reduction) should be considered in knowledge-based companies. Aligned with the findings of the present study, the obtained results of Ozdemir (2019) and Qu (2019) also showed that the use of the IoT in the health sector can lead to cost and time savings. Similarly, Qasem (2019) also believes that using this technology cause considerable cost reduction. Khedmatgozar (2015) maintains that the IoT can be employed as a reliable basis for the production of data on knowledge processes, especially the discovery of knowledge in physical and digital environments.

Conclusion

In this study, there was an attempt to present a model for the use of IoT in knowledge-based companies using a mixed heuristic approach and grounded theory method. The main driving force for conducting this study was the obvious paucity of a model or framework for IoT use in Iranian knowledge-based companies. In this research, all of the factors and elements which can exert any influence in this regard are categorized and elaborated. The proposed model includes five main categories and 19 subcategories. The main factors were named as context, mediating conditions, strategies, causal conditions and consequences.

Based on the results, the process of using IoT in the Iranian knowledge-based companies can be explained by the fact that the governments can exert any changes in these companies through making negotiations to reduce sanctions and indirectly by increasing cooperation between the two countries, changing the rules, creating the necessary infrastructure and context. The enhancement of international cooperation by providing the necessary ground for scientific and commercial cooperation for the use of IoT in knowledge-based companies can play an important role in this direction. Resistance requirements are also effective in using the IoT through economic stability and attracting investment. The prevailing conditions of the country also play a decisive role in the use of this technology by amending the laws, changing the country's management structure, reducing investment risk, reducing inflation, expanding the cooperation of the country's universities, and stabilizing the exchange rate. Also, creating the necessary infrastructure and supplying raw materials will have a great impact on encouraging the use of the IoT. It is also expected to increase the chance to use IoT by adopting policies such as documenting the previous experiences of corporate executives, developing strategic plans for companies, creating a professional team in the field of technology, establishing a quality control unit, increasing teamwork, the appointment of experienced, using flexible and risk-taking managers, training of the negotiation and teamwork skills to managers, attracting specialized manpower, giving opportunities to young people and transferring experiences to them.

Research Suggestions

According to the research results and the factors influencing the use of IoT, the following suggestions are presented:

a) Developing the infrastructures in the country, b) the emphasis of the relevant officials on improving conditions in the country by reducing tensions with other countries and trying to lift sanctions, c) the focus of knowledge-based companies on customer orientation, d) the attention of the relevant officials to the allocation of government currency to the raw materials of the IoT, e) the attempts of relevant companies to develop cooperation with the international companies, f) the efforts of relevant officials to increase commitment, knowledge acquisition, and productivity, as well as establish a quality control unit and teamwork in their company, g) their attempt to develop the skills of their managers in the ability to negotiate, teamwork, flexibility, acceptability, risk-taking and equipping them with the latest managerial achievements, h) hiring professional, experienced, young, creative, knowledgeable and innovative staffs.

Conflict of interest

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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