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Fuzzy Analysis of the Influence of Factors on the Integration of Telecommunication Technology Infrastructure Using ANFIS

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ABSTRACT

The issue of integration in different industries is very important and brings many benefits at different economic and social levels. Given the size of the telecommunications industry, this industry is no exception to this rule and It is very clear that setting up telecommunications infrastructure to create businesses based on it requires a lot of expenses, and for this reason, integrating the existing infrastructure so that all service providers can use it from the aspects variety is of interest also the integration of telecommunications infrastructure creates a lot of added value. But the interactions between tangible and intangible indicators have emerged by doing so, which policymakers must consider. Our goal is to study the integration of telecommunications infrastructure and study its interactions on factors identified by experts and then verified. To achieve the correct result, after collecting the opinions of industry experts, using the fuzzy Delphi method and after the steps of this method, the effective factors were examined and the basic indicators that should be considered were identified and ranked and cclassified. Then the effect of each index was investigated through the formation of a neural network. The importance of the engineering perspective in the telecommunications industry has its place, but the place of the technological perspective and reviews with managerial approaches has not been properly seen, especially in our country. These results are a new approach in the telecommunications industry and design an innovative model for this industry.

1. Introduction

Management analysis on engineering functions has its own complexities and it is very difficult to provide management solutions to working engineers [11]. The wider and more sensitive the industry, the more profound challenges managers and engineers face. The approach of this article is based on one of the most complex

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management issues of the country's telecommunication industry. What can definitely be said about it is that the solution of this problem cannot be achieved only with engineering perspectives and the introduction of management knowledge is necessary to solve it [1]. Integration is one of the important categories in technology and industries, because the launch of each technology requires its own costs and resources, and with integration, we are witnessing a significant reduction in these matters [22].

The issue of infrastructure is one of the most important concerns and issues of the city, which is essential to do other things, because doing any work is based on the existence of infrastructure related to it. For example, car traffic requires street and road infrastructure, and street lighting is based on the existence of electricity transmission infrastructure. Such infrastructures are related to communication. As in order to establish communication between homes, people, offices and organizations, we need a suitable infrastructure for establishing telephone communication, and also the infrastructure related to mobile phones can be considered as it covers all of our lives.

In the meantime, paying attention to the multiplicity and diversity of telecommunication infrastructures, the costs of setting up these infrastructures is an important point, and integrating them will reduce related costs, facilitate and accelerate the establishment of communications.

But the existence and presence of different stakeholders causes integration to face various issues, so that sometimes service providers give up on integration and do parallel and independent work at the same time. It is in the midst of this that management knowledge must reach the silent cry of technology and examine non-engineering and engineering issues in an integrated manner and extract the final solution. For this reason, the influence of factors and stakeholders on integration should be well seen and investigated. In this article, an attempt has been made to analyze the neuro analysis of the influence of factors and stakeholders that are effective in this matter.

Therefore, after stating the literature on the subject and the prerequisites to be mentioned, the extraction of the effective factors that were obtained through experts and were qualitative, were quantified using the triangular fuzzy Delphi technique and their refinement was done. Triangular fuzzy numbers are used due to their high efficiency and greater ease in calculations, in this way, in these numbers, the upper limit means the highest acceptable value of the parameter and the lower limit means the lowest value, and the third number is the most probable number that can be authorized. In this way, all the factors and their impact have been investigated and tried to put the existing factors within the acceptable range by going back and forth with the experts. were considered Then, using the neural network analysis that was done through ANFIS, the effect of each of the factors of the first stage on the result, that is, the integration of telecommunication infrastructure, was investigated. The general schools of economics and experts in science and technology development policies emphasize the need for general policies, and there is disagreement about the existence and implementation of specific policies. In fact, all societies and governments have a mission for national and regional governments to provide a platform for the development of science and technology and its transformation into innovation [5]. Technology and research and development activities have a tremendous impact on the market and financial implications of technology-oriented organizations. Creating new technologies or selecting and utilizing existing technologies is a constant issue for organizations ([17]. Therefore, in order to achieve an integrated design, it is necessary for the various services defined in the design to be able to interact and collaborate with each other at different levels, including process, data, application interface, and infrastructure [2] is one of the extensive technologies in the telecommunications industry. To meet this need, the most common and widely used platform and infrastructure needed to increase this connection are telecommunication sites [20]. This is clearly outlined in the chart below.

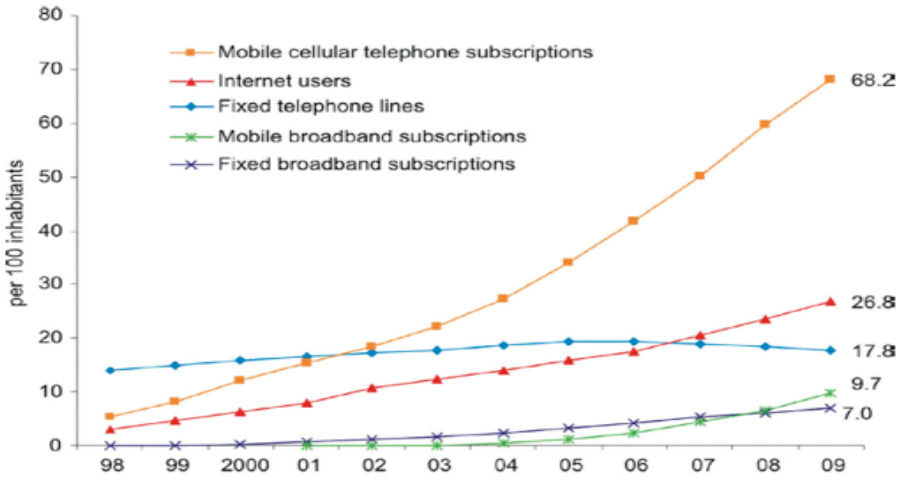

Figure 1. Increased mobile and Internet usage compared to landline Competitiveness Review (2013)

The revenue of the telecommunications industry in our time has a large share of GDP [13]. This causes many investors to operate in this industry and in addition to providing personal economic benefits in Public growth is also affected and by creating innovation in this industry to provide various added value [14] and of course the optimization of these investments is desirable for all, thus the actors of the communications industry, to create infrastructure [4]. The increasing growth of demand has led to the emergence of more supply in this market, and consequently the required infrastructure begins to increase [3]. This causes the emergence of telecommunication sites with different towers and technologies and in different urban places, including the roofs of residential houses or their yards and some public places, has become the older operators of this industry who used the monopoly of services for a significant period of time. Have more suitable urban places, and perhaps the attitude of government public services to their service, caused the pad All organs would cooperate with them. With the passage of time and the presence of others for mobile phone operators and the emergence of competition between operators and the emergence of their revenue generation, city managers, especially municipalities, have been more careful in allocating space to establish a telecommunications site, and therefore new operators with coverage issues And encountered communication defects. Increasing the number of telecommunication sites that are responsible for serving mobile and Internet subscribers, in addition to distorting urban landscapes and city-appropriate furniture, environmental challenges, waste of energy and resources, community mental health and some parameters It exposes other hidden and overt in society to danger [15].

These issues have become more apparent as competition between operators has increased. To achieve better coverage and attract more customers, each operator created its own infrastructure by installing telecommunication towers. Each of these towers has a different shape and image, and each was located in its own area, without considering issues related to urban furniture, so that some inside the courtyards of residential houses and others on the roofs of houses and some of they were installed in schools, offices, parks, etc. For each site, relatively the same physical equipment is used, which on a large scale causes the loss of resources such as metals, gypsum, cement, soil, etc. In addition to involving the country's resources, this will create less clean waste, especially since the physical equipment of the project has a useful life and must be collected after a period of depreciation, including equipment that due to technological upgrades and transformations, they have to be removed from telecommunication sites, which creates a significant amount of waste. It is clear that each of these telecommunication sites uses its associated energy consumption for cooling systems and communication between other sites. Each benefits from a separate electricity meter, which in turn leads to more public infrastructure and more resources. In some areas, when establishing telecommunication sites, we have faced popular opposition and complaints to the judiciary, which has caused and continues to cause social harm and disputes between neighbours in a neighbourhood. On the other hand, and from the policy-maker’s point of view, the overhead costs of establishing different sites that can be integrated and each using common raw materials to

establish telecommunication sites are a waste [10,18]. Also, each of them has its own radiation that must be organized in a way that eliminates annoying signals. Concerns for policymakers and city managers cover many issues and have led to budget allocations to address some of these issues. In many countries, companies have been set up to address this issue only to provide physical infrastructure for operators, and they can use it to provide optimal service, especially in the United States, more than one hundred companies providing services for telephone operators. They are active together, some of whom have achieved very high incomes and have a large market. On the other hand, rapid changes in technology and the emergence of high volumes of investment to create communication platforms have led some of the industry leaders to think of using integrated infrastructure using the least physical facilities and thus make optimal investments. Ericsson has designed mobile sites that are able to use the equipment available on a mobile site to service three operators simultaneously [9]. Our main problem is:

Is it possible to innovate for the integration of telecommunication infrastructure? What is its model like?

The inventory issues mentioned above indicate that numerous cases and various actors are effective in expanding the telecommunications infrastructure, which is itself a clear reason for the need to address this issue and the gap and the need for in-depth study and model of dealing with these issues in politics. The macros are quite obvious. This research is innovative because in the telecommunication industry, despite the need for a large infrastructure, its integration has not been considered and the impact of various factors has not been considered to do it and also a method has not been designed for how to do it. The main goal of this study is finding the impact of factors that include the interests of stakeholders and actors in the field of telecommunications and economic justification, in a way that allows integration in this technology. We hope that the innovation in this article will attract the attention of telecommunication policymakers and policymakers.

2. Literature Review

One of the most basic concepts mentioned in the subject of the article is the issue of integration. Therefore, this concept should be discussed and its background should be extracted. The extent of integration in different industries will be discussed and its importance will be stated. Another issue that needs to be addressed is infrastructure so that its concept can be fully articulated and its inclusion examined. Naturally, the issue of infrastructure integration will also be addressed, and then we will discuss the integration of telecommunication infrastructure.

2.1 Integration

As is evident from the word integration, it means turning one or more collections into an integrated environment. Of course, the meaning of this word becomes clearer along with the suffixes that belong to it. For example: information integration means creating a connection between information from different sources, which is composed of different concepts, contexts and forms (Same document) or that the integration of telephone and computer mean the integration of telephone and computer (The same document). Such extensions, each of which contains a new concept for integration, can be referred to such as: integration of biceps, battlefield, macro-macro, macro, and so on. These indicate the widespread use of integration in various industries. The multiplicity of tools, concepts, sciences, etc. has astonished human beings in doing things; therefore, by considering the concept of integration and integration, an attempt has been made to reduce multiplicity. It goes without saying that integration costs are high on many systems [6, 7, 8] this issue should be weighed in the economic parameters for investment. They include cities. However, less attention has been paid to how this is done in practice. We claim that technological innovation is historically very important for the development of cities and is also very important in the smart cities that will emerge in the future. When cities use analytical data and techniques to improve efficiency and effectiveness; they become much smarter. Integration of physical and digital infrastructure can play an important role in these goals. Now the engineering tools and models used in the design, construction and operation of urban infrastructure can utilize a variety of different technologies and processes to assist in this integration. This is a very necessary and challenging point that the participation of different parties and groups should be used to help create integration and take into

account the various concerns of infrastructure and technology owners [7].

2.2 Infrastructure

The term has become popular in recent years and has been used in any type of technology system or business organization with the increasing popularity of the proposed internal format. The term "underlying infrastructure" has been widely accepted to distinguish those infrastructure factors that, if severely damaged or destroyed, could cause serious failure of the affiliated system or organization. Damage from a hurricane or earthquake has led to the loss of specific transportation resources in a city (for example, bridges over a river), making it impossible for people to move and provide emergency services in an emergency; these pathways are referred to as the basic infrastructure. Similarly, an online airline booking system may be considered as a basic infrastructure. Today, new tools such as BIM building information modeling are used to control and implement infrastructure projects, which in addition to benefits such as improving productivity and reducing costs, also lead to project success [16]. Infrastructure is a group of interconnected structural factors that cause urban structure. Infrastructure may have many meanings, but in urban planning, most of the passages, streets, sewers, etc. are inferred from it. The development of a process and a process that is evolving and improving the current situation according to the culture and material and spiritual needs of human societies, which must be done with respect for the environment and its laws to ensure the well-being of human beings in the present and in the future to provide the grounds for their material and spiritual growth in the path of worldly and otherworldly happiness and prosperity. Development literally has similar meanings such as social change, social growth, social evolution, modernization of progress, expansion and progress. The progress of any country depends on the progress of each individual Anyway. In Asia, the largest city in terms of population, level of social, economic and cultural facilities is so large that other first-class cities in the country seem small and insignificant compared to it. Elimination of obstacles and problems and creating opportunities for the development of the country's cities depend on the infrastructure that is planned and implemented in advance. Therefore, the infrastructure is moving towards the goals in parallel and in coordination with the development, so that if any of them stops moving or moves more slowly, the development will undoubtedly be further away from its goals. Urban infrastructure is very important in relation to architecture due to the geographical location of sustainable development - environmental sustainability, and environmental issues that have endangered the human future have forced architects to think of solutions, and environmental sustainability is to leave the earth in the best shape. For the next generation with the definition that human activity is only environmentally sustainable when it can be implemented without reducing natural resources or degrading the natural environment. Today, in countries and cities, plans for progress are made with a view to the future, and our country is no exception. In the urban landscape, where programs are written and implemented, sustainable urban development can be guaranteed by providing appropriate urban ecological infrastructure [12,19].

2.3 Telecommunication infrastructure and its effects

Our topic is specifically related to telecommunications infrastructure, so the concept that has many applications in the telecommunications industry should be examined from different aspects. According to the Ministry of Communications and Information Technology, the communication network is the responsibility of the government to create telecommunications infrastructure. Therefore, they have established a company under the supervision of the Ministry of Communications. And the Internet bandwidth operates, and in practice has the monopoly on the import and distribution of Internet bandwidth throughout the country. The company, as the custodian of the mother telecommunication network in the country and the agent of the Ministry of Communications and Information Technology, is responsible for switching and providing inter-provincial and international communications of telecommunication operators in the presence points and related networks. Considering the subject of the research, infrastructure is a set of systems of the country's telecommunication infrastructure network, including intercity and international microwave centers, main fiber-optic network, ground-based telecommunication satellite stations, telecommunication transit canters (PC, SC), STP and International (ISC) and Core Data Network, which provides the capacity for intercity and international traffic

transmission and routing required by all agencies, organizations and operators. The concepts mentioned state that the telecommunication infrastructure includes everything that is needed to communicate. The breadth of these tools and infrastructures leads to better communication and provides a platform for improvement in other industries [16]. Economic and social infrastructure, telecommunications infrastructure has been associated with the growth of various factors and for this purpose many cases have been studied in this field, for example Nigeria in a study examined data from 1980 to 2012 and considering the significant impact of infrastructure development on the country's economic growth in 1992. This led to the adoption of a strategy for the country that can attract foreign investors to develop its infrastructure [17] examined the impact of telecommunications infrastructure on the economic growth of 21 organizations in the OECD and 14 developing OECD member countries between 1970 and 1990. They eventually came up with a model and a causal relationship. They found a gap between telecommunications infrastructure and overall efficiency, which is the case in OECD countries It showed itself more [13]. In this regard, the impact of telecommunications infrastructure on the economy of Arab countries that produce oil or do not benefit from oil production was also examined and its impact was examined. In most of these communication studies, many of the effects of telecommunications infrastructure on economic growth were obtained [13].

2.4 Infrastructure integration

According to the explanations given, creating an infrastructure in all aspects to be able to meet the needs of society is a difficult and costly task that requires a lot of budgets. This is also the reason why some countries try to create the required infrastructure by creating investment attractions and inviting investors and carrying out projects in the form of BOT, which was mentioned in the case of Brazil (Same document). Infrastructure is a tool to achieve the goal and is built to create opportunities in society. The performance of the current infrastructure is such that it is not designed based on increasing demand and is ultimately unstable. In this infrastructure, the lack of integration of end users in terms of diversity of their requests, needs and behaviors, beliefs and needs should all be considered. To achieve long-term sustainability, infrastructure must be operated at a level that utilizes minimal resources. For this reason, 1- The behavior of end users should be fully identified 2- The focus should be on services 3- Information technologies should be used more effectively 4- Integration in the direction of different infrastructure systems 5- Recognize the complexities related to infrastructure 6- Revision of current evaluations. New configurations and multi-purpose companies may be needed to achieve long-term sustainability [18]. The issue of telecommunications infrastructure integration is one of the many issues mentioned in the integration. For this reason and because of the importance of the subject, we mention some cases in this field. Over the past two decades (1990 to 2010), electricity and ICT infrastructure have become increasingly interdependent. This is a combination of factors that include a variety of factors, including sensors, network technologies and software, and advances in deployment, all of which depend on a proper understanding of WANs. The ability of network operators to use the data obtained in this way provides better returns. In particular, coordination, density management and variable integration in transmission system management are provided. In addition, many services are created across the country, such as investments in sensor systems, AMI infrastructure consisting of smart meters, communication networks and information management systems. It is predicted that in the next few years, US grid customers will have smart meters and will not need to visit the meter in person [21]. With the expansion of infrastructure integration in developed countries, various issues and inconsistencies have arisen. The stimuli of recent decades, the data and modeling capabilities for simulation, the dependencies required for infrastructure development have led to incentives for integration by various groups such as emergency preparedness and green policy advocates. Integration strategies for energy systems and water resources have been explored and have been done well in some other areas. In short, integration in the United States starts from the ground up, because in many cases it has many effects and risks on climate change. Successes in the field of integration indicate that integration is increasing over time [23]. Despite the issues that have arisen, a number of emerging trends suggest that even richer new data streams related to distribution system operations will be available in the coming years due to the proliferation of smart devices and network-related sensors throughout the system, based on the interdependence of electricity and ICT

infrastructure. It must be acknowledged that this connection creates potential vulnerabilities in the field of cyber security, and barriers must continue to be removed by focusing on research and development and information sharing with industry. However, the convergence of power grids and ICTs also promises to be a major platform for energy innovation, leading to the creation of new values and improved resilience in the system. The speed with which this convergence takes place and the emergence of new services and operational methods depends on a number of factors, including regulatory structures that define the framework in which programs and network operators prioritize infrastructure investment decisions [23]. It should be noted that the expansion of communications in the world and the need to perform various operations such as: controlling energy and measuring its consumption, controlling and directing such things as traffic, different uses of materials, security control, the possibility of directing all means, smart transportation, smart cities, etc. requires telecommunications infrastructure. Of course, creating these infrastructures for each organ separately is not cost-effective. For example, if the Ministry of Energy wants to develop telecommunication infrastructure to measure energy consumption while delivering energy to consumers, it will miss its main mission because the creation and development of infrastructure requires huge costs. And the government budget must be allocated to it, and this mission must be entrusted to an independent body. Or to control traffic and urban pollution, we need to install surveillance cameras at the city level, which means the need for communication infrastructure to communicate and perform the duties of the relevant body. Now imagine that the police and the municipality, together with the Ministry of Energy, each build their own infrastructure, no good things will happen to the country at the macro level, as many resources will be wasted in parallel. It should be noted that the continuation of infrastructure activities requires the support and specialized institution, and this means that each of these institutions must provide the necessary expertise. In this way, huge costs had to be incurred for the development of the infrastructure, and this causes the cost to increase, making the infrastructure unprofitable and ultimately unused, resulting in all the investment, time and manpower. Wasted and the optimality of the investment is challenged. Unfortunately, these events have happened many times in this country, from the waste of resources due to the lack of a specialized institution to doing parallel affairs and the failure of many of them. An objective example that we see on highways and roads is the existence of various cameras, many of which are unused, and the reason is the lack of a specialized institution at the time of purchase and installation, which with the change of technology and the lack of a specialized institution, maintenance and supply of parts has been problematic and has led to a fundamental overhaul, so when will this happen again for this new technology that we have to wait for. Some things that are not obvious are not obvious to the general public, many fiber-optic infrastructures have been created by different agencies and ministries. During the years after installation and lack of proper maintenance, these infrastructures are faced with a problem that no one is aware of, and only when they need to use it, they realize that it is not able to provide services. In this way, the wealth allocated to create it so that it can provide services when needed, is wasted and it is not possible to exploit it. These matters must be managed by governments. Specialized institutions and the Ministry of Communications should be responsible for building all the infrastructures on a very large scale. The cost of this infrastructure must be depreciated over many years of service to lower the cost of services based on it. Strategies for using services should be so simple that no one, whether natural persons or legal entities, need to build infrastructure and use it to focus on the development of their services. The fifth-generation mobile phone, which is also supposed to be responsible for IoT services, needs a complete infrastructure. Mobile services in this country are the responsibility of private institutions that face various issues in the relevant bodies to create the infrastructure they need. He is in contact with the Ministry of Communications for development and frequency licenses, and with the municipalities to get space to establish telecommunication sites, to use fiber optics, sometimes to the municipal networks, sometimes to the Iranian telecommunications and sometimes to the infrastructure network. It goes without saying that Tavanir network and infrastructure are also used. All this confusion is due to the lack of coordination and integration between these organs in creating the network, and therefore creates many problems for those who need this infrastructure, because each organ in each city does its job with its friends and policies. It goes ahead, and that means that the private sector in each place has to move in a specific way that is different from

other places. In the meantime, there is the development of the fifth generation, which is on the agenda of the government according to the development programs. Despite these infrastructures, if the government management is not able to integrate them, new costs will have to be incurred to create a complete infrastructure, which means wasting financial and human resources and, most importantly, the time needed to start. It is important when using technologies. Imagine the need to use and develop IoT technology in the meantime, which can have a single infrastructure with the 5th generation mobile phone [14]. Businesses based on this technology in recent years have contributed many It has a global turnover in developed countries that we in our country will not be able to use for years if we are not unaware of them.

3. Research method

The research method is applied in terms of purpose because its results can be used in policy to attract investment in order to integrate telecommunications technology infrastructure and promote the telecommunications industry. And since fuzzy Delphi has been used for research, it is qualitative research. Since in order to study the interaction of components, the suffix has been used, the research can be considered as a method, mathematical modeling. Therefore, the research can be considered as mixed (quantitative-qualitative). In this regard, a questionnaire was prepared to assess the impact of factors and sent to experts. Experts are experts in the telecommunications industry who are concerned about the development of infrastructure for telecommunications development and are aware of the impact of the expansion of telecommunications infrastructure on developments in the world. Due to the mentioned limitations, the results of a questionnaire of 15 people from the industry denial were selected to participate in this research and their opinions were used. After sending the questionnaire and collecting it, the indicators that were computationally disproportionate to the others were removed and other indicators proposed by the experts were replaced and the questionnaire was sent to them again with the results. After repeating this article, firstly, we obtained a questionnaire that was agreed upon by the experts, and secondly, the indicators were evaluated, and the method of doing the work and the calculations performed will be described in detail below. After that, we used the opinions of 67 experts to combine neural and fuzzy networks.

4. Recognize the Indicators Affecting Integration

In this research, we proceeded to the fuzzy Delphi method to research and examine the opinions of the elites. The Delphi technique is a powerful process based on group communication structure that is used in cases where incomplete and unreliable knowledge is available with the aim of achieving group consensus among experts. The questionnaire was reviewed and modified with experts and the results were as follows:

- Refinement of identified factors using fuzzy Delphi technique:

In this stage of the research, according to the characteristics mentioned for the members of the expert group in the statistical community, the following steps were performed*:*

A) Definition of linguistic variable*:*

Experts were asked to express their agreement through verbal variables such as very low, low, medium, high and very high. Since different characteristics of individuals affect their mental interpretations of qualitative variables, by defining the range of qualitative variables, Experts have answered the questions with the same mindset. These variables are defined according to Table 1 of triangular fuzzy numbers.

In Table 1, the definite fuzzy numbers are calculated using the Minkowski formula as follows

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

In Equation (1), X denotes the definite value of the fuzzy number, m represents the central triangle, β the right domain, and α the left domain.

Table 1. Triangular fuzzy numbers and verbal variables

Defined fuzzy number	triangular fuzzy number	Verbal variables
0.۹ 375	(0,0.25,1)	Very much
0.75	(0.15,0.15,0.75)	High
0.5	(0.25,0.25,0.25)	Medium
0.25	(0.15,0.15,0.25)	Low
0.0625	(0,0,0.25)	Very low

B) The first stage

In the first stage, the selected components are sent to the members of the expert group and their agreement with each of the components is obtained and the proposed and corrective points of view are summarized. According to the proposed options and linguistic variables defined in the questionnaire, the results of the study and the answers provided in Table 2 are presented. According to the results of this table, the fuzzy mean of each component is calculated according to the following relations

$$A_1 = (a_1^{(i)}, a_2^{(i)}, a_3^{(i)}), i = 1,2,3,\ldots,n \quad (2)$$

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

Table 2. Results of counting the answers of the first stage of the survey and the average views of experts

	Components			Degree of agreement				
		Defaulted mean	Triangular fuzzy mean(m, α, β)	very much	High	medium	Low	Very low
۱	Knowledge	۰	(۰.۵۸ ,۰.۱۹ , ۰.۱۵)	۳	٤	٤	۳	۱
۲	Cultures	۰.٦۲	(۰.٦۳ ,۰.۱۹ , ۰.۱٤)	٤	٤	٤	۲	۱
۳	different sciences	۰.۲۸	(۰.۲۷ ,۰.۱۳ , ۰.۲۰)	۰	۱	۳	۷	٤
٤	Finance and investment	۰.۳۳	(۰.۳۲ ,۰.۱۲ , ۰.۱۹)	۱	۲	۲	٥	٥
٥	Grow contracts	۰.۲۳	(۰.۲۰ ,۰.۱۱ , ۰.۲۱)	۰	۰	۳	٦	٦
٦	Industry	۰.٥٥	(۰.٥٥ ,۰.۲۰ , ۰.۱۸)	۲	۳	۷	۲	۱
۷	beneficiary	۰.۳۷	(۰.۳٥ ,۰.۱۲ , ۰.۱۹)	۱	۳	۲	٤	٥
۸	Cloud	۰.٥٦	(۰.٥۷ ,۰.۱۹ , ۰.۱۸)	۲	٤	٦	۲	۱
۹	Artificial intelligence	۰.٦٥	(۰.٦۷ ,۰.۲۰ , ۰.۱٥)	۳	٦	٤	۲	۰
۰۱	Mobile Phone	۰.٦۱	(۰.٦۲ ,۰.۱۹ , ۰.۱٦)	۲	٦	٤	۳	۰
۱۱	Social Medias	۰.٦٤	(۰.٦٥ ,۰.۲۰ , ۰.۱٥)	۳	٥	٥	۲	۰
۱۲	Big Data	۰.٥٦	(۰.٥۷ ,۰.۱۹ , ۰.۱۸)	۲	٤	٦	۲	۱
۱۳	Drone	۰.۲۹	(۰.۲۷ ,۰.۱۳ , ۰.۲۱)	۰	۱	٤	٥	٥
۱٤	Internet Of Things	۰.٥۲	(۰.٥۲ ,۰.۱۸ , ۰.۱۸)	۲	۳	٦	۲	۲
۱٥	climate	۰.۷۳	(۰.۷٥ ,۰.۱۹ , ۰.۱۲)	٤	۸	۲	۱	۰
۱٦	Energy	۰.٥٦	(۰.٥۷ ,۰.۱۸ , ۰.۱٦)	۳	٤	٤	۲	۲

In Eq. (2), A_i represents the expert view of i and *Aave* represents the average of the expert views. Also, a_1, a_2, a_3 also represent the triangular fuzzy number. The results of these calculations are shown in Table 2.

In Table 2, the mean of the triangular fuzzy is calculated using Equation 1 and then de-fuzzy using the Minkowski formula. The results of the first step are shown in Figure 2.

C) The second stage poll

In the second stage, while applying the necessary changes in the factors affecting the integration of mobile infrastructure, a second questionnaire was prepared and sent to the members of the expert group with the

previous point of view of each person and the extent of their differences with the average point of view of others. After conducting the second stage survey, according to the views presented in the first stage and comparing them with the results of this stage, since the difference between the two stages was much less than the threshold (0.1), the poll process continues. The threshold is calculated from the following equation:

$$s(A_{m2}, A_{m1}) = \left| \frac{1}{3}\left[(a_{m21} + a_{m22} + a_{m23}) - (a_{m11} + a_{m12} + a_{m13}) \right] \right| \quad (4)$$

In Eq. (4) (a_{m21}, a_{m22}, a_{m23}) expresses the expert opinion in the second stage (a_{m11}, a_{m12}, a_{m13}) also indicates the expert opinion in the first stage, which shows the difference of opinion in two stages with S (A_{m2}, A_{m1}). The results of the second stage survey answers are presented in Table 3.

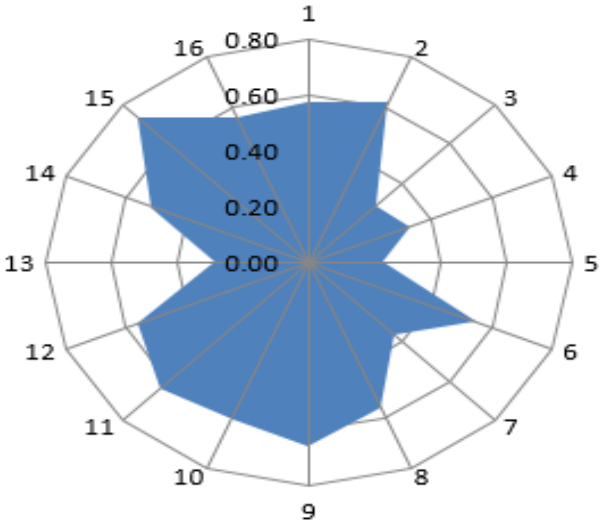

Figure 2. Results of the first phase of the expert survey

According to Figure 2, the components that have a lower average score (less than 0.3) will be removed from the calculations due to their low importance. This eliminates the following factors:

•Different sciences
• Growth of contracts
•Drone

After reviewing the forms of the first stage of the survey and receiving expert opinions from the open forms and questions, the following changes occurred in the factors:
Factors 15 and 16, ie climate and energy, are merged due to the proximity of the concept and are added to the research under the title of environment.

The following factors are also added to the model:
• Coordination with contractors

As can be seen in Table 4, the variables No. 3 and 5, ie "Finance and Investment" and "Stakeholders", the amount of difference between their two stages is much lower than the threshold (0.1), so the questionnaire in the third stage is distributed among experts to bring their views closer together.

D) The third stage poll

In this stage, the questionnaire is sent to the experts again along with the results of the previous stage, so that by observing the opinions of other experts, they can bring their opinions closer to each other. The results of this step are presented in Table 5.

Table 3. Results of counting the answers of the second stage of the survey and the average views of experts

	Component			Degree of agreement				
		Defaulted mean	Triangular fuzzy mean(m, α, β)	very much	High	medium	Low	Very low
١	Knowledge	٠.٤٧	(٠.٤٧ ,٠.١٨ , ٠.١٨)	٢	٢	٥	٤	٢
٢	Cultures	٠.٤٦	(٠.٤٥ ,٠.١٧ , ٠.٢٠)	١	٣	٦	٢	٣
٣	Finance and investment	٠.٦٥	(٠.٦٧ ,٠.١٩ , ٠.١٤)	٤	٥	٤	١	١
٤	Industry	٠.٥٣	(٠.٥٣ ,٠.١٩ , ٠.١٧)	٣	٢	٦	٢	٢
5	beneficiary	٠.٦٤	(٠.٦٥ ,٠.١٩ , ٠.١٥)	٣	٦	٤	١	١
٦	Cloud	٠.٤٩	(٠.٤٨ ,٠.١٧ , ٠.١٩)	١	٤	٥	٣	٢
٧	Artificial intelligence	٠.٥٣	(٠.٥٣ ,٠.١٩ , ٠.١٩)	١	٤	٧	٢	١
٨	Mobile Phone	٠.٥٨	(٠.٥٨ ,٠.١٩ , ٠.١٧)	٢	٥	٥	٢	١
٩	Social Medias	٠.٥٦	(٠.٥٧ ,٠.١٩ , ٠.١٨)	٢	٤	٦	٢	١
0١	Big Data	٠.٥٠	(٠.٥٠ ,٠.١٨ , ٠.١٨)	٢	٣	٥	٣	٢
١١	Internet Of Things	٠.٤٣	(٠.٤٢ ,٠.١٥ , ٠.٢٠)	٠	٤	٥	٣	٣
١٢	environment	٠.٥٦	(٠.٥٧ ,٠.١٩ , ٠.١٦)	٣	٣	٥	٣	١
١٣	Coordination with contractors	٠.٦٣	(٠.٦٣ ,٠.١٩ , ٠.١٦)	٣	٥	٥	١	١

Table 4. The difference between the first and second steps

	Componenet	first stage	Second Stage	The difference between the first and second stage
1	Knowledge	(٠.٥٨ ,٠.١٩ , ٠.١٥)	(٠.٤٧ ,٠.١٨ , ٠.١٨)	0٠٣۴۴.
2	Cultures	(٠.٦٣ ,٠.١٩ , ٠.١٤)	(٠.٤٥ ,٠.١٧ , ٠.٢٠)	05٠.١١
3	Finance and investment	(٠.٣٢ ,٠.١٢ , ٠.١٩)	(٠.٦٧ ,٠.١٩ , ٠.١٤)	1267٠.
4	Industry	(٠.٥٥ ,٠.٢٠ , ٠.١٨)	(٠.٥٣ ,٠.١٩ , ٠.١٧)	0122٠.
5	beneficiary	(٠.٣٥ ,٠.١٢ , ٠.١٩)	(٠.٦٥ ,٠.١٩ , ٠.١٥)	1111٠.
6	Cloud	(٠.٥٧ ,٠.١٩ , ٠.١٨)	(٠.٤٨ ,٠.١٧ , ٠.١٩)	03٠.٢٢
7	Artificial intelligence	(٠.٦٧ ,٠.٢٠ , ٠.١٥)	(٠.٥٣ ,٠.١٩ , ٠.١٩)	03٠.٠٠
8	Mobile Phone	(٠.٦٢ ,٠.١٩ , ٠.١٦)	(٠.٥٨ ,٠.١٩ , ٠.١٧)	0078٠.
9	Social Medias	(٠.٦٥ ,٠.٢٠ , ٠.١٥)	(٠.٥٧ ,٠.١٩ , ٠.١٨)	0233٠.
10	Big Data	(٠.٥٧ ,٠.١٩ , ٠.١٨)	(٠.٥٠ ,٠.١٨ , ٠.١٨)	0278٠.
11	Internet Of Things	(٠.٥٢ ,٠.١٨ , ٠.١٨)	(٠.٤٢ ,٠.١٥ , ٠.٢٠)	0367٠.
12	environment	--	(٠.٥٧ ,٠.١٩ , ٠.١٦)	03٠.٠٦٧
13	Coordination with contractors	--	(٠.٦٣ ,٠.١٩ , ٠.١٦)	3٠.٢٨٩

Table 5. The third stage poll

	Components			Degree of agreement				
		Defaulted mean	Triangular fuzzy mean(m, α, β)	very much	High	medium	Low	Very low
١	Knowledge	٠.٤٨	(٠.٤٨ ,٠.١٩ , ٠.١٩)	١	٣	٦	٤	١
٢	Cultures	٠.٥٠	(٠.٥٠ ,٠.١٩ , ٠.١٩)	٢	٢	٧	٢	٢
٣	Finance and investment	٠.٦٨	(٠.٧٠ ,٠.٢٠ , ٠.١٣)	٤	٦	٣	٢	٠
٤	Industry	٠.٥٩	(٠.٦٠ ,٠.٢١ , ٠.١٧)	٣	٣	٧	١	١
٥	beneficiary	٠.٦٦	(٠.٦٧ ,٠.٢٠ , ٠.١٦)	٢	٧	٥	١	٠
٦	Cloud	٠.٥٣	(٠.٥٣ ,٠.١٩ , ٠.١٨)	٢	٣	٦	٣	١
٧	Artificial intelligence	٠.٤٦	(٠.٤٥ ,٠.١٧ , ٠.٢٠)	٠	٤	٦	٣	٢
٨	Mobile Phone	٠.٥٢	(٠.٥٢ ,٠.١٩ , ٠.١٩)	١	٤	٦	٣	١
٩	Social Medias	٠.٥٢	(٠.٥٢ ,٠.١٧ , ٠.١٩)	١	٥	٥	٢	٢
0١	Big Data	٠.٤٣	(٠.٤٢ ,٠.١٧ , ٠.٢٠)	١	٢	٦	٣	٣
١١	Internet Of Things	٠.٥٠	(٠.٥٠ ,٠.١٨ , ٠.١٩)	١	٤	٦	٢	٢
١٢	environment	٠.٥٠	(٠.٥٠ ,٠.١٩ , ٠.١٨)	٢	٢	٦	٤	١
١٣	Coordination with contractors	٠.٦٥	(٠.٦٧ ,٠.٢٠ , ٠.١٥)	٣	٦	٤	٢	٠

Table 6. The difference between the second and third stages

	Components	Second Stage	Third stage	The difference between the second and third stage
1	Knowledge	(۰.۴۷ ,۰.۱۸ , ۰.۱۸)	(۰.۴۸ ,۰.۱۹ , ۰.۱۹)	0122۰.
2	Cultures	(۰.۴۵ ,۰.۱۷ , ۰.۲۰)	(۰.۵۰ ,۰.۱۹ , ۰.۱۹)	02۰.۱۱
3	Finance and investment	(۰.۶۷ ,۰.۱۹ , ۰.۱۴)	(۰.۷۰ ,۰.۲۰ , ۰.۱۳)	0078۰.
4	Industry	(۰.۵۳ ,۰.۱۹ , ۰.۱۷)	(۰.۶۰ ,۰.۲۱ , ۰.۱۷)	0278۰.
5	beneficiary	(۰.۶۵ ,۰.۱۹ , ۰.۱۵)	(۰.۶۷ ,۰.۲۰ , ۰.۱۶)	0122۰.
6	Cloud	(۰.۴۸ ,۰.۱۷ , ۰.۱۹)	(۰.۵۳ ,۰.۱۹ , ۰.۱۸)	02۰.۱۱
7	Artificial intelligence	(۰.۵۳ ,۰.۱۹ , ۰.۱۹)	(۰.۴۵ ,۰.۱۷ , ۰.۲۰)	03۰.۲۲
8	Mobile Phone	(۰.۵۸ ,۰.۱۹ , ۰.۱۷)	(۰.۵۲ ,۰.۱۹ , ۰.۱۹)	0167۰.
9	Social Medias	(۰.۵۷ ,۰.۱۹ , ۰.۱۸)	(۰.۵۲ ,۰.۱۷ , ۰.۱۹)	02۰.۱۱
10	Big Data	(۰.۵۰ ,۰.۱۸ , ۰.۱۸)	(۰.۴۲ ,۰.۱۷ , ۰.۲۰)	0233۰.
11	Internet Of Things	(۰.۴۲ ,۰.۱۵ , ۰.۲۰)	(۰.۵۰ ,۰.۱۸ , ۰.۱۹)	03۰.۲۲
12	environment	(۰.۵۷ ,۰.۱۹ , ۰.۱۶)	(۰.۵۰ ,۰.۱۹ , ۰.۱۸)	0167۰.
13	Coordination with contractors	(۰.۶۳ ,۰.۱۹ , ۰.۱۶)	(۰.۶۷ ,۰.۲۰ , ۰.۱۵)	0078۰.

As can be seen, since the difference between the two stages is less than the threshold, it is very small (0.1), the poll process is stopped.

4.1 Presenting a conceptual model of research

Considering the mentioned cases and what was obtained based on the results of the fuzzy Delphi method, the conceptual model of Figure 4 can be concluded, which expresses the interaction between the indicators and the integration of infrastructure.

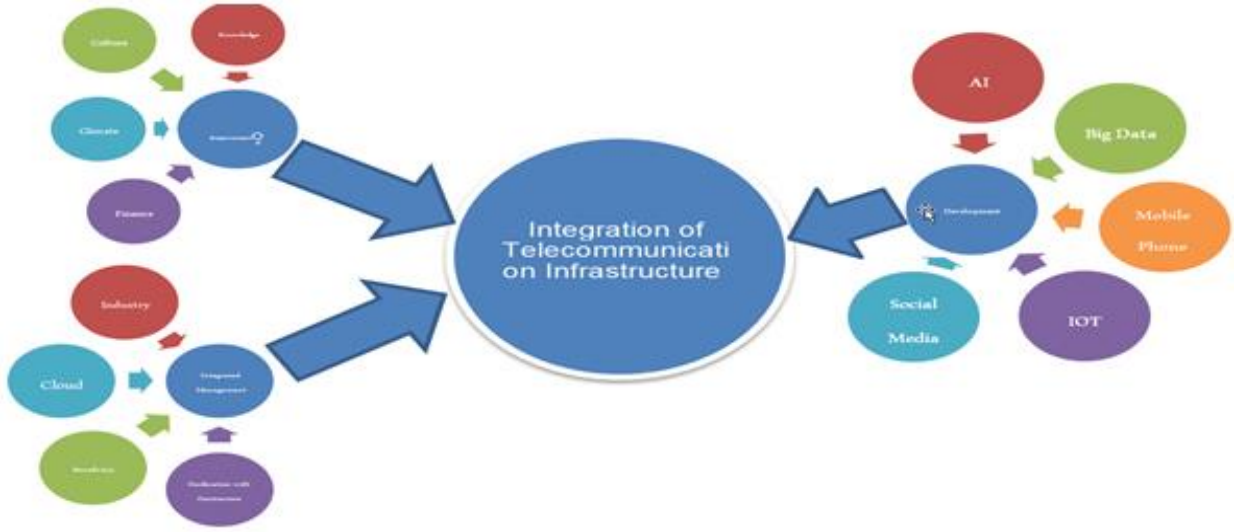

Figure 3. Conceptual model of research

The above factors are indicators that are effective on the integration of telecommunications infrastructure and are important.

4.2 Ranking and neural network formation

As can be seen in the executive method, after performing fuzzy Delphi, the indexes were ranked and the fuzzy Delphi output, which was taken from the opinions of experts, was used as the input of the neural network through ANFIS.

4.3 Quantitative part analysis (neural network analysis with ANFIS software)

In this part, a combination between nervous and fuzzy systems was performed. This system is also called fuzzy neuro phase. ANFIS combines the advantages of using neural networks and fuzzy logic. The neural

network has the advantages of learning, optimization and balancing, and the fuzzy system is based on rules made by experts. For the present study, we needed to construct several adaptive fuzzy neural subsystems and combine them.

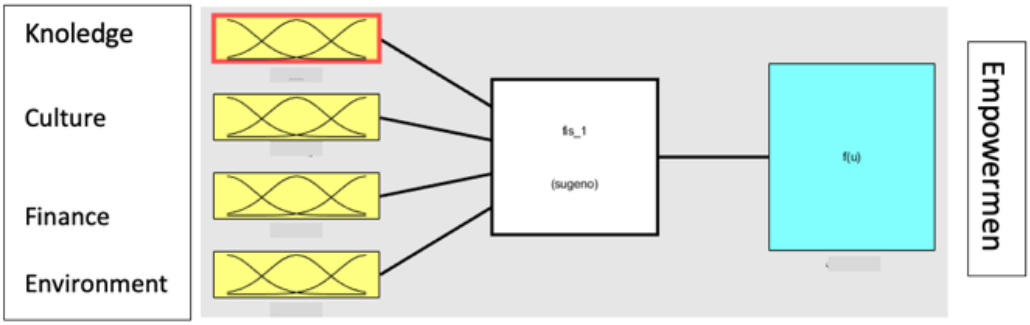

Figure 4. Neural network factors affecting empowerment

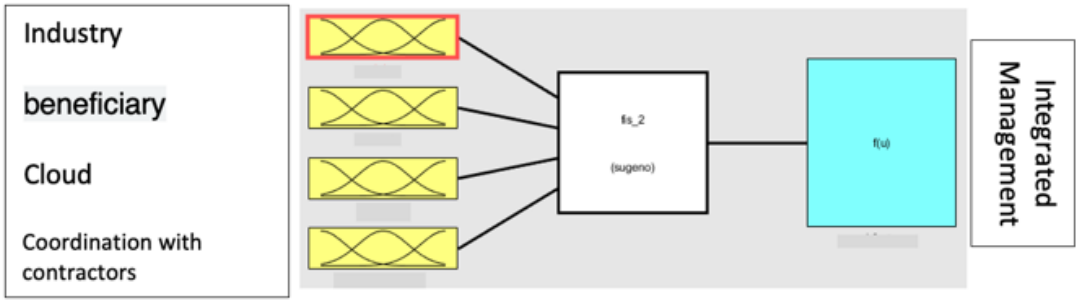

Figure 5. Neural network factors affecting integrated management

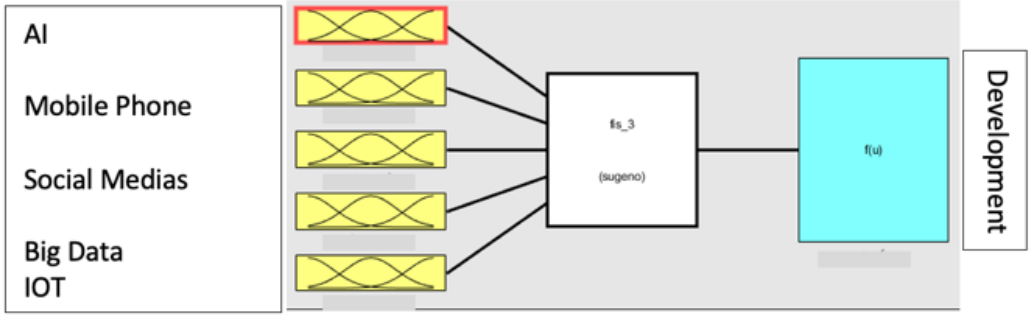

Figure 6. Neural network factors affecting development

Figure 7. The final model of the neural network

5. Discussion and Conclusion

This article was formed with the aim of investigating the interaction effects of effective indicators on the integration of telecommunication technology infrastructure to be able to innovate in the formation of this model with a new approach by conducting studies and extracting indicators and factors affecting it after distribution. Questionnaire to experts and their response analysis was done by fuzzy Delphi method and neural network formation. As can be seen from the conceptual model, various factors affecting the integration were extracted through the fuzzy Delphi method. It was observed that the issue of finance and investment, which in fact includes economic issues, led to the repetition of the second and third stages of fuzzy Delphi, which indicates the sensitivity of this issue in integration. The fuzzy mean of this factor, which is higher than other factors, is another difference of this important factor in the subject of research. This means that the answer to the research question includes the effect of financial factor and capital. Investing in integration is very important and the economic factor is one of the most important factors. Of course, according to the research findings, other factors should not be neglected; other factors indicate the results of the sub-questions. It is necessary to pay attention to the fact that in order to integrate the telecommunication infrastructure and considering the results of the neural network, all the mentioned factors should be considered and the policy should be made in such a way as to include the influential factors and to involve all of them. Have a plan. Otherwise, integration with all the benefits and preconditions mentioned above, so that developed or developing countries have benefited or are benefiting from those benefits; It will not be feasible and moving towards it will cause more waste of resources. By observing the results of the neural network, innovative hacks can be suggested, for example: Construction should promote knowledge, culture and financial issues. Thus, in the ANFIS model, it is observed that the maximum effect can be achieved for the model. Therefore, a specific practical proposal is to raise the level of culture, knowledge and financial strengthening of the industry. Therefore, it is recommended that policymakers, by creating attractive economic factors and optimal investment, which is also of great importance and leads to higher productivity for the private sector, help the various stakeholders involved in the private sector to meet the bulk of the needs. To regulate, the private sector, due to the dependence of its material life on technological activities, will expand technology within the proposed framework, and thus the production of wealth will take place at the macro level, and of course the interests of policymakers in other sectors and levels will be provided. It can be seen that this entire path is realized by macro-level policy by the government and in the direction of optimal investment and not wasting resources by the private sector.

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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