JOURNAL OF MANAGEMENT AND ACCOUNTING STUDIES 2020(04)

Available online at http://journals.researchub.org

Using Analytical Hierarchy Process (AHP) in selection of suitable platform to present communication services to subscribers

Mariah Alaghband*

[*]University of central Florida, Orlando, Florida, USA

ARTICLE INFO

Article history:

Received 08 July 2020
Received in revised form 19 Aug 2020
Accepted 24 Sept 2020

Keywords:
Communication, Telecommunications,
Communicative platforms,
Analytical Hierarchy Process (AHP)

ABSTRACT

Before emerging internet and data network, remote communication had a clear meaning: Telephone (telegraph before it) was the only technology that allowed people to communicate by voice from remote distance. After 1960, fax and data were presented in Public Switched Telephone Network (PSTN). Recently, remote communications have been developed and they include data transmission, video conference, email, instant messages, web browsing and potential for transmission of multimedia content. Today, consumers think about two categories of products and services relating to communications. Tendency of consumers to purchase communicative applications or equipment has growingly become pervasive as products and services and the used technology for remote communications has changed to great extent during 50 years ago. Using semiconductors and digital electronic devices in telecommunication industry could replace analog sound with images and video. Then, switching circuit was completed and it should be more unlikely substituted with packet switching. All these changes indicate a new definition of remote communication: The communication is a group of technology, devices, equipment, installations, networks and software programs that support telecommunication. It has been tried in this paper to identify important parameters and criteria in communication field by utilization from Analytical Hierarchy Process (AHP) technique to interpret suitable platform for presentation of communicative services for subscribers and by recognition and dividing platforms in which there is potential for giving services to the subscribers.

1. Introduction

During his/her life, human has always utilized a device for communication thereby to transfer his/her message to others. Therefore, s/he has not been called superior of creatures unreasonably. Human was not too different from animals at the beginning of his/her genesis because s/he exchanged information by their method namely by touching and facial gestures etc. but these primitive devices were simple and inadequate to meet his/her needs because of his/her curious and agitated spirit.

In the past periods and very long time ago, human has used face-to-face and vis-à-vis communications and sent messages for others by drum and smoke. At this era, human was not aware of outside world of his/her small and limited society and saw all the world in his/her own limited and small group. Therefore, by trying for more communication with his/her surroundings human obtained oral language in long term and used it for better and more effective communication. Human entered oral galaxy in which content has been more addressed, relationship is done directly (audiovisual) and human has employed five senses for communication, but hearing sense was dominant and it is more suitable than other sense in lingual relation between humans.

Nonetheless, in oral galaxy human also encountered several problems to convey his/her messages and requests and needed to more developed devices for communications until about 700BC year when a great invention occurred in Greece and it was alphabet letters.

Invention of alphabets made speech and writing close together similar a bridge and settled differences between them. Distances were removed and human could think about transferring thoughts and sent it to others. Three-millennium evolution of oral tradition and non-alphabetic relationship prepared the ground for this historical turning point that was the start point for qualitative transformation in human communications. Literacy was not developed until several centuries after invention and spreading printing industry and paper production (Castles, 2001:382).

Invention of printing by Guttenberg caused human to acquire written communication in addition to direct relationship and following to starting this phase, human entered writing age or Guttenberg's Age. McLuhan believes that 'The world of human inhabited in Guttenberg galaxy is composed of the world of

**Corresponding author:* Mariah.Alaghband@gmail.com
DOI: https://doi.org/10.24200/jmas.vol8iss04pp61-70

straight and subsequent lines, the world of beliefs in fixed and known theories, classification world, a world in which anything should be placed at specific class and effect only originates from a determined cause.' (Mohsenian Rad, 1990:487)

The necessity for information and exchange of data became greater by rising population and distribution of them on earth planet. The human, who used resistant runner, fast horses and letter-courier pigeons to send his/her messages at that time and from press and newspapers in another time, could not yet fulfill the main need that was fast data exchange. S/he needed to a device to transmit his/her message faster. Invention of electricity and then emerging telegraph by Samuel Morse, British inventor, in 1832 caused human to transfer data to distant places with high speed and by simple codes. However invention of telephone by Alexander Graham Bell and Thomas Edison (American inventor) in 1876 was a great development because rather than overcoming on time and place, he could hear voice of another human several kilometers distant from oneself. Invention of telephone enabled human to converse with individuals a few kilometers distant from him/her by cable, although telephone essentially affected rising speed communication, due to using cable, there was still some restriction in communication and it required for a device to transmit data in space without cable and by light speed and pass through barriers and it was nothing except radio.

Following to invention of radio at the end of nineteenth century and early years of twentieth century, human entered electronic age that relied on remote communications and hearing sense was the dominant sense. By invention of wireless and radio communication by Guglielmo Marconi, Italian inventor, in 1895, news and data were propagated to distant points at amazing speed. In 1957, Russians enabled communication outside earth planet using Popov's thought and the first artificial satellite called Sputnik was sent to earth orbit.

The flooding spread of computer within recent decades has created the most important change in knowledge system since invention of print in 15th century or even since script invention. Along with this extraordinary transformation, spreading networks and media, which are responsible for transferring knowledge and related constituent elements namely data and information, is identically marvelous. If nothing was changed, a development of these two elements again confirmed knowledge revolution, but continuous transformations will gradually change this knowledge system or information segment in Hi-Tech world (Toffler, 1995:649).

Of course, development in data exchange tools was accompanied with the tools designated for data storage. In fact, these two processes are not separated from each other because data accumulation, concentration of experience and knowledge is what individuals, generations and nations have left as heritage for their post generations over the history. By recording or memorizing data, as they are, we store information for close or far future (Azarang, 1992:34). Alternately, when there is some communicative equipment and data storage tools by composition of three different technologies namely computer industries, software and programming, cinema and TV and telecommunication industries (telecommunication and electronic) data super highway is created in which various audiovisual information is transferred to consumer by cables made of optical fiber.

Therefore, it can be implied that in 1980s, modern technologies exposed world of media to change and by this transformation media could spread data at wide level and create explosion in terms of quantity of data, but due to removing public mass, number of audiences of these media has been restricted in this period and mass of audiences has been turned into smaller groups.

Modern technologies are technologies produced after 1970s. Information Technology (IT) includes computer data networks that have transformed quality and quality of available information in revolutionary and unprecedented way. Similarly, satellite technology has led to emerging of electronic media throughout the world. Revolutionary effects of optical fiber and satellite technology on motility of various data and images enable reaching to world-wide multimedia information super highways. Increase in computer power and software, and developments in IT have contributed to density of world by different ways (Oxford, 1999:144).

In any case, these modern communication technologies are effective in all fields; for example, in political field, citizens can solve their problems and issues with their statesmen via internet or electoral candidates can act via internet; as a result, technology and know-know have influenced in nature of power.

IT has also led to some changes in economy; for instance, it has caused accelerating international commercial correspondences, cash flows, goods and between individuals by several technological advancements these trends have been more accelerated (Seifzadeh, 1999:174).

With respect to the exerted changes in communication devices and their role in today human life, it can be concluded that we witness change in communication patterns and we could not deny this change and developing bilateral approaches. These modern technologies deeply affect personal and social relations and change our vision about surrounding world. On the other hand, instead of sending a message for the public mass and creating similarity and parity, it is sent for non-massive and small groups and this is led to segmentation. Overall, it can be said this modern technology is economic for many planning and managerial activities.

As a result, It can be implied that over the history human has always tried to have a device for communication; although, these devices had no great potential to convey message and information during primary periods, they were favorable for the human at that time. These primitive technologies have been gradually developed to the extent at present we encounter information technologies that are transforming lifestyle and thinking of contemporary human.

1.1. Analytical Hierarchy Process (AHP)

With respect to rational limit by which any human is undergone lonely, perhaps cooperation and group synergy can be the only solution to achieve a logical, regular, comprehensive and complete decision-making system. Today, modern organizations have been developed and become so complex only an individual could not manage them alone and the manager has to ask others for help in making decisions and administration of organizational activities (Adel Azar, 1994).

Several techniques have been employed for making effective decision such as brainstorming, Delphi technique and nominal group technique. Although using these techniques has partially solved the group decision-making problems, employing them may be problematic for spending time and cost. In

addition, decisions are so complex in today complicated and turbulent world that using aforesaid techniques is practically impossible and it needs to a comprehensive technique more than ever (Adel Azar, 1994).

Analytical Hierarchy Process (AHP) is one of the most well-known multipurpose decision-making methods that were invented for the first time by Thomas El Saaty, who was Iraqi national, in 1970s. This technique is used when decision-making is exposed to rival choice and criterion for making decision. The aforesaid criteria may be quantitative and qualitative. The basis of this decision-making technique lies in pairwise comparisons. The decision maker starts the process by providing hierarchical decision tree. The hierarchical decision tree indicates compared factors and evaluated rival choices in decision. Then, a series of pairwise comparisons is done. These scales specify weight of each of factors along with rival choices. At last, AHP logic integrates resulting matrices from pairwise comparisons to achieve optimal decision. Using AHP on group decision making will cause not only to keep advantages of group decision-making, but to remove their defects (e.g. speed, cost and single thought). (Adel Azar, 1994)

1.2. Description of generalities of AHP model

Employing this technique requires for four major following steps:

a) Modeling

At this step, the problem and goal of decision making are extracted hierarchically from decision elements in relation with each other. Decision elements include decision-making elements and decision choices. AHP process needs to break this problem with several parameters into hierarchy of levels. The higher level denotes main goal of decision-making process. The second level indicates major and basic elements that can be broken into minor and more partials parameters at the next level. The last level presents decision choices. The hierarchy of a decision is shown in the following figure (Mehregan, 2004:170).

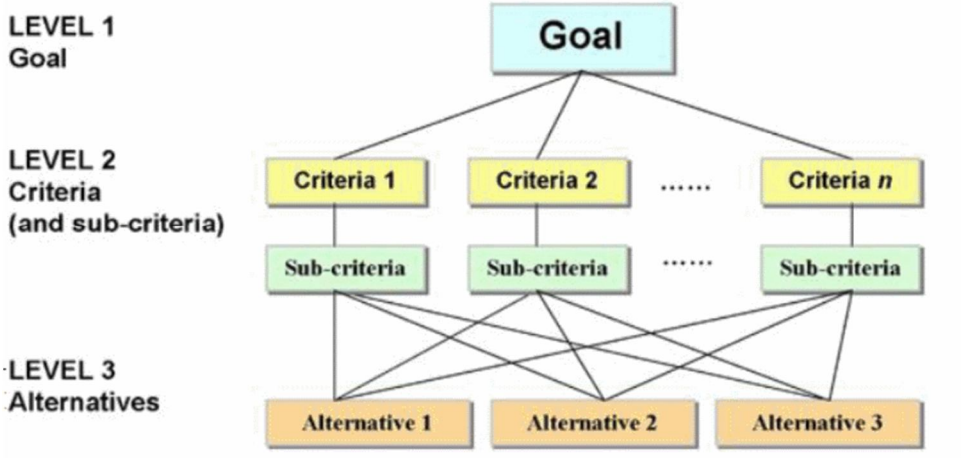

Fig 1. Model of AHP structure

b) Preferred judgment (pairwise comparisons)

By conducting comparisons between various decision choices based on any parameter and judgment, decision-maker should create a group of matrices, which measure numerically relative importance or preference of parameters compared to each other and any decision choice with respect to parameters versus other choices after design of decision problem hierarchy. This action is done by pairwise comparisons between two decision elements (comparison by pairs) and through assignment of numerical scores that represent preference or importance among two decision elements. To do this, the choices are compared with i^{th} parameters or j^{th} parameters.

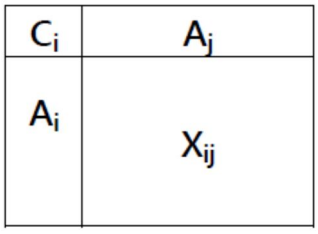

Fig 2. Pairwise comparison of choices and criteria

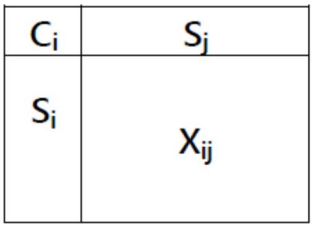

Fig 3. Pairwise comparison of sub-criteria and criteria

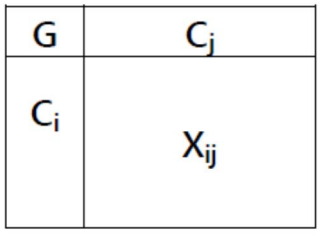

Fig 4. Pairwise comparison of criteria and goal

c) Determination of importance coefficient (weight) for criteria and sub-criteria

Criteria and sub-criteria are primarily compared with each other to determine relative importance coefficient (weight) of criteria and sub-criteria. Weight of any factor shows its importance and value versus other factors. Thus, conscious and proper selection of weights may highly contribute to determine the given goal. The pairwise comparisons are recorded in $n \times n$ matrix and this matrix is called matrix of binary comparison of criteria. Table 1 indicates Saaty 9-quantity scale for pairwise comparison of criteria.

Table 1. Saaty 9-quantity scale for binary comparison of criteria

Score	Definition	Description
1	Equal importance	Two criteria have the same importance in realizing goal.
3	Slightly more importance	Experience shows that i is slightly more important than j.
5	More importance	Experience indicates that i is more important than j.
7	Very much importance	Experience shows that f is highly more important than j.
9	Absolute importance	A lot of importance of i versus j has been proved.
2, 4, 6, 8	Medium importance	When there are medium states

To compute importance coefficient (weight) of parameters, four major methods are proposed as follows:

1- Ordinary Least Square (OLS) technique
2- Logarithmic Least Square technique
3- Eigenvalue method
4- Approximation methods

Among above-said techniques, eigenvalue method is employed more, but if binary matrices of parameters have high dimension, calculation of values and eigenvalues will be long-run and time-consuming. Hence, four approximation techniques are used for this purpose:

1- Sum of row method
2- Sum of column method
3- Arithmetic mean technique
4- Geometric mean technique

The following rules should be observed upon pairwise comparison.

Reverse condition: If preference of element-A to B set as n then preference of element-B to A will be 1/n.

Homogeneity rule: Element-A should be homogenous and comparable with element-B. in other words, the preference of element-A to B could not be infinite or zero.

Dependency: Any hierarchical element can depend on its element at higher level and such dependency can continue linearly to the highest level.

Expectations: If any change occurs in hierarchical construction the evaluation process should be repeated (Godsipoor, 2002:6).

To calculate importance coefficient of parameters by geometric mean computation, firstly geometric mean should be derived for columns of binary matrix of parameters and then they are normalized (dividing any element of matrix to sum of column of the same element).

d) Determination importance coefficient of choices

The importance coefficient should be determined for choices after determining importance coefficients of criteria and sub-criteria. At this phase, if a criterion lacks sub-criterion, preference of each of choices for each of sub-criteria will be judged directly with the same criterion. Saaty 9-quantity scale is assumed as basis for judgement but it is different in that this point is not significant which choice is more important in comparing choices while it is significant which choice is more preferred. Thus, Saaty 9-quantity scale will be considered as judgment basis for choices as it described in Table 2.

Table 2. Saaty 9-quantity scale for binary comparison of choices

Score	Definition
1	Equal preference
3	Partially preferred
5	More preferred
7	Much more preferred
9	Totally preferred
2, 4, 6, 8	Medium preferences

e) Consistency in judgments

Almost all calculations related to analytical hierarchical process are conducted according to initial judgment of decision-maker within matrix of pairwise comparisons and any error and inconsistency in comparison and determination of importance between choices and parameters may tarnish final result derived from the computations. The inconsistency rate with which will be later familiarized how to calculate it is a tool to specify consistency and it indicates how much one can trust in the preferences resulting from comparisons. For example, if choice-A is more important B (preference value 5) and B is relatively more important (preference value 3), then it should be expected that A should be evaluated much more important than C (preference value 7 or higher) or if preference value of A to B is 2 and B to C is 3 then the preference value of A to C should be 4. Perhaps, comparison of two choices is a simple task, but when quantity of comparisons is increased it could not be trusted in consistency of comparisons easily so by employing consistency rate one should achieve such trust. Experience has shown if consistency rate is lesser than 0.10 the consistency of comparisons is reasonable; otherwise, comparisons should be revised.

The following steps will be taken to calculate consistency rate:

Step 1- *Weighted Sum Vector (WSV) technique*: Multiply pairwise comparisons to relative weight columnar vector thereby to derive a new vector and call it weighted sum vector.

Step 2- *Calculation of consistency vector*: Divide elements of weighted sum vector to relative preference vector. The resulting vector is called consistency vector.

Step 3- Derivation of λ_{max} results in mean elements of λ_{max} consistency vector.

Step 4- Calculation of consistency parameter: Consistency parameter is defined as follows:

$$I.I = \frac{\lambda_{\max} - n}{n-1}$$

Where, *n* denotes number existing choices in the problem.

Step 5: *Calculation of consistency ratio*: Consistency ratio is derived by dividing consistency parameter to Random Index (RI).

$$I.R. = \frac{I.I.}{I.I.R}$$

The random index is extracted from the following table.

Table 3. Random index table

N	2	3	4	5	6	7	8	9	10	11	12	13	14	15
I.I.R	0.0	0.58	0.9	1.12	1.1	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

The consistency ratio 0.1 or lower denotes consistency in comparisons (Mehregan, 2004: 170-173).

f) Merging relative weights

For ranking of decision choices at this step, the relative weight of any element should be multiply to weight of higher elements to derive final weight. The weight of final weight is derived by doing this phase for any choice.

1.3. Expert Choice software

Expert Choice software is a strong tool for multi-criteria decision making based on Analytical Hierarchy Process (AHP) that was proposed for the first time by Thomas El. Saaty as one of the founders of Expert Choice in University of Pennsylvania.

Expert Choice includes a unique technique to use pairwise comparisons and extraction of preferences that can produce more accurate results with very high precision of your comments compared to other reflection techniques. This software combines and integrates the given preferences in any part of your decision-making process to specify finally general preference of your choices.

1.4. Case study: Evaluation and measurement of communication platform to present telecommunication services to subscribers

Data is transferred in computerized and telecommunication networks by three various media: copper cable, wireless medium and optical fiber. Copper is very expensive and copper cables are used mainly within short distances because rather than their cost-consuming in long distances, the transmitted signal loses power due to noise, attenuation and distortion effects and in order to keep this power it needs using several relays in different distances where this also leads to higher costs. Similarly, we are exposed to limitation of bandwidth in cooper cables. As you know, bandwidth is created by increase in frequency of input signal but copper cables could not tolerate frequency under any condition because high frequencies are attenuated more quickly. The other defect of copper cables is their low security since the current is passed through them can be intercepted by induction currencies and they are deciphered easily by decoding.

The primary material of optical fiber is glass which is very cheaper than copper and whereas transmission is done at light speed there thus it has high bandwidth and these are light stripes transferred and since light has high frequency therefor no signal can create noise on it. Thus, optical fiber is very much resistant to noise while this entangled light strip could not radiate outside fiber and consequently it is also highly secured. If the used glass if fiber lacks impurity to transfer data to long distances with no least attenuation thus optical fiber is highly reliable since fiber has little error and it can be ensured data to be transmitted to receiver with the least error.

Despite wireless networks are highly effective in remote communications they are assumed as the least protected and insecure media. Wireless media are sensitive to noise and very noise susceptible so that cosmic noises e.g. wind and rain can even affect them.

To collect data in this study regarding process of evaluation and analysis of quality of telecommunication service giving, copper cable, optical fiber and radio communication platforms have been utilized by consultation with experts of Telecommunication Company of Qom Region. At this step, experts and technicians were asked to express service-giving criteria and parameters to subscribers regardless of communication platform.

With respect to the collected data, the following criteria were implied as the most original and foremost criteria and parameters in service-giving according to comments of experts:

- Quality of service
- Diversity of service
- System upgrading and development
- System security
- Maintenance
- Cost

The modeling and drawing of decision tree is done after identifying criteria and parameters.

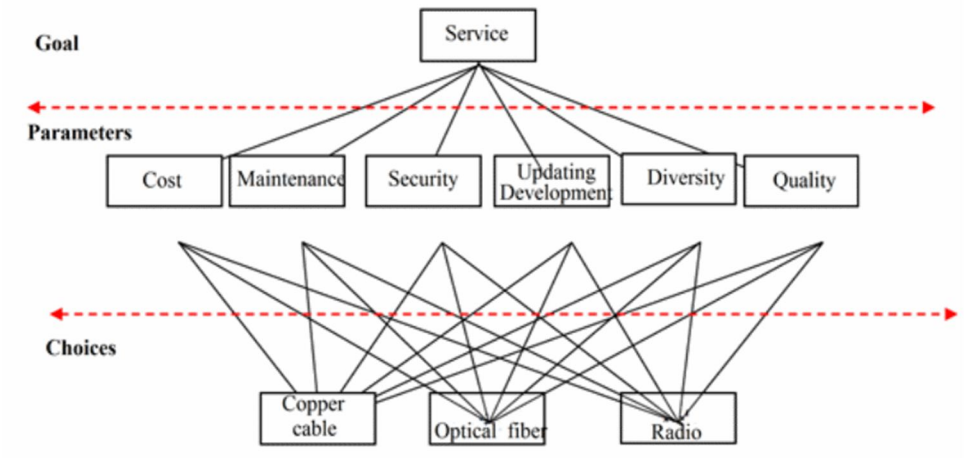

Fig 5. Hierarchical structure model

After drawing decision tree, we should form pairwise comparison matrix for any level versus higher level. To start this task, firstly we enter goal, parameters and choices in Expert Choice software. Then, we will perform pairwise comparisons at any level versus higher levels.

1.5. Pairwise comparisons between choices and each of parameters and weight calculation

1- Pairwise comparisons of choices and cost parameter

Table 4. Pairwise comparison matrix of choices and cost parameter

Quality	Copper cable	Optical fiber	Radio
Copper cable		2	2
Optical fiber			2
Radio			

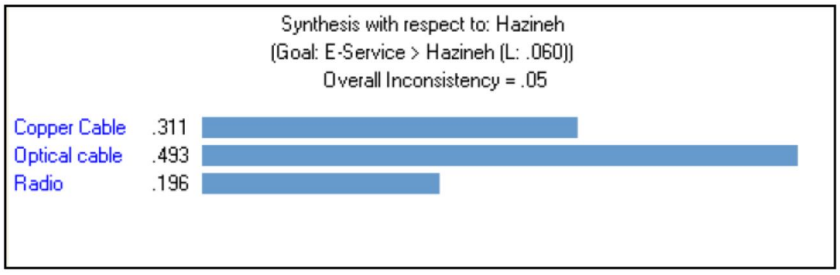

Fig 6. Calculation of weight for choices versus cost parameter in Expert Choice

2- Pairwise comparisons of choices and maintenance parameter:

Table 5. Pairwise comparison matrix for choices and maintenance parameter

Quality	Copper cable	Optical fiber	Radio
Copper cable		3	2
Optical fiber			4
Radio			

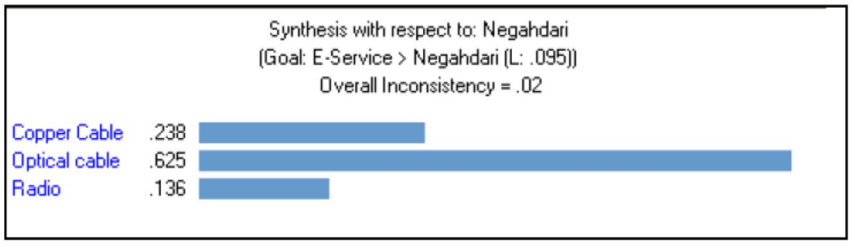

Fig 7. Calculation of weight of choices versus maintenance parameter in Expert Choice

3- Pairwise comparison matrix for choices and security parameter:

Table 6. Pairwise comparison matrix for choices and security parameter

Quality	Copper cable	Optical fiber	Radio
Copper cable		3	2
Optical fiber			4
Radio			

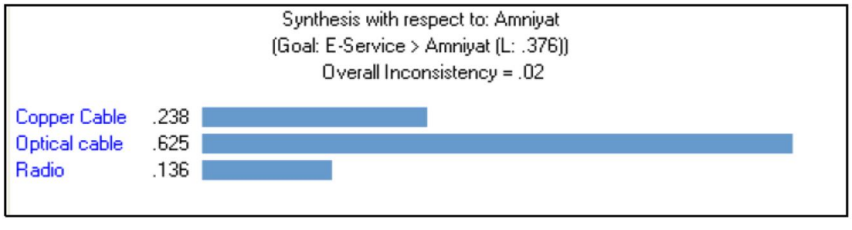

Fig 8. Calculation of weight of choices versus security parameter in Expert Choice

4- Pairwise comparisons for choices and updating and development parameter:

Table 7. Pairwise comparison matrix for choices and updating and development parameter

Quality	Copper cable	Optical fiber	Radio
Copper cable		3	2
Optical fiber			4
Radio			

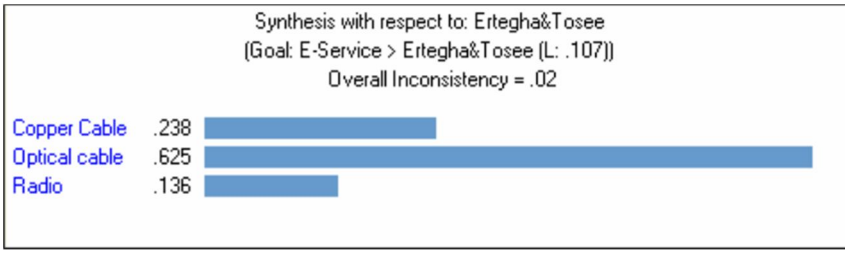

Fig 9. Calculation of weight of choices versus updating and development parameter in Expert Choice

5- Pairwise comparisons for choices and diversity parameter:

Table 8. Pairwise comparison matrix for diversity parameter

Quality	Copper cable	Optical fiber	Radio
Copper cable		2	5
Optical fiber			6
Radio			

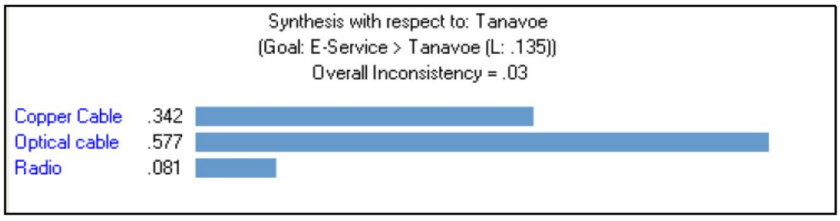

Fig 10. Calculation of weight of choices versus diversity parameter in Expert Choice

6- Pairwise comparisons for choices and quality parameter:

Table 8. Pairwise comparison matrix for choices and quality parameter

Quality	Copper cable	Optical fiber	Radio
Copper cable		2	3
Optical fiber			4
Radio			

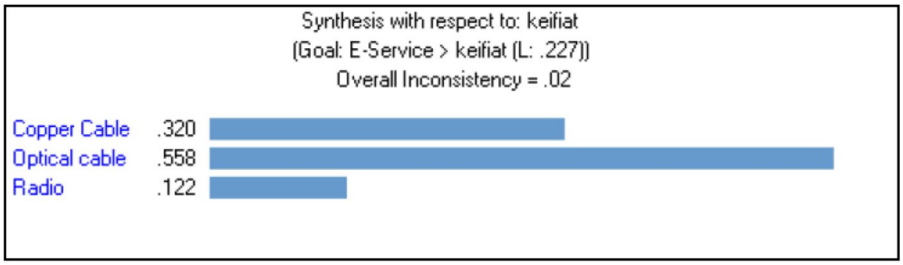

Fig 11. Calculation of weight of choices versus quality parameter in Expert Choice

7- Pairwise comparisons of parameters and goal:

Table 10. Pairwise comparison matrix for parameters and goals (Service-giving)

Service giving	Quality	Diversity	Updating and development	Security	Maintenance	Cost
Quality		3	3	3	2	3
Diversity				3	2	2
Updating and development				3	2	2
Security					4	4
Maintenance						3
Cost						

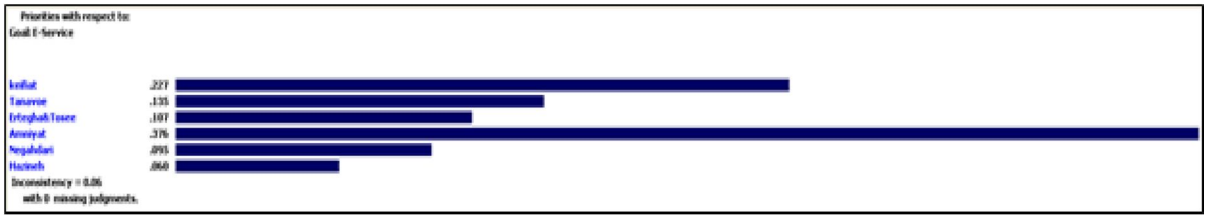

Fig 12. Calculation of weight of parameters versus goal (service-giving) in Expert Choice

At the end, the final weight of parameters is obtained versus goal and weight of choices compared to parameters using the given data namely pairwise comparison matrices of parameters versus goal and pairwise comparison matrices of choices versus parameters. The operational process has been done by Expert Choice program.

1.6. Selection of preferred choice

By merging relative weights, importance rate and final order-preference for each of choices at this phase the best choice is selected by Expert Choice software. With respect to outputs of program in this example, choices are prioritized as follows:

1-Optical fiber

2-Copper cable

3-Radio

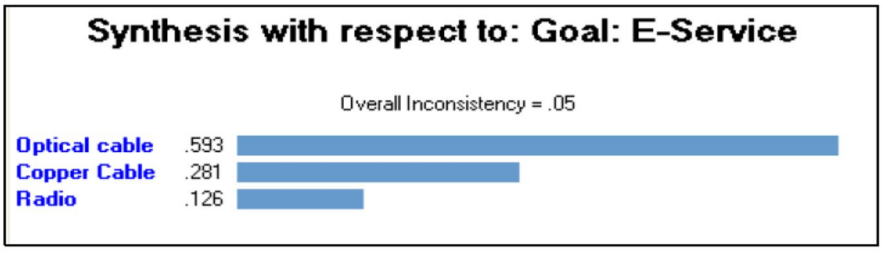

Fig 13. Selection of the best choice in Expert Choice

2. Conclusion

The excessive increase in communication and information as well as existing content in internet and also changing their pattern into multimedia has caused some countries to look for execution of various projects to increase doubly their speed and bandwidth. In this regard, communication technology of optical fiber utilizes guided light to transfer data instead of copper cables or radio waves today and it can reduce hazards of radio waves to human body in addition to increase quality of communication level. The optimal fiber communications are based on this principle that the light in a vitreous medium van carry more data in long distances versus electrical signals in copper media or radio frequencies in wireless systems. Today, quality of optical fibers has been improved along with advancement of electronic systems and accordingly optical fibers can transmit light signals to long distance even more than one hundred kilometers without losing quality. The optical fiber is deemed as an almost ideal medium for transmission with lower losses in transmission path, very low interference and high potential of wide bandwidth.

By using optical fiber one can access to wide bandwidth at mazing speed up to 100megabyte per second and in addition to this dramatic speed it can be benefitted from some facilities e.g. unlimited numbers of phone lines, internet TV with HD quality, control and access to visual monitoring systems and

security cameras, control and surveying smart home systems without time and place limits and only by means of high-speed internet and among them the noticeable point is the very lower cost for using from these services compared to traditional platforms of copper cable and radio wave. Compared to classic infrastructures, the cost of access to this platform is almost something less than one-third and this is led to reducing monthly household costs and provides more access to state-of-art technology and online services for all classes of society.

REFERENCES

Bigdeli, S., & Kaufman, D. (2017). Digital games in medical education: Key terms, concepts, and definitions. *Medical journal of the Islamic Republic of Iran, 31,* 52.

Ferreira, A. T., Araújo, A. M., Fernandes, S., & Miguel, I. C. (2017, April). *Gamification in the workplace: A systematic literature review.* In World conference on information systems and technologies (pp. 283-292). Springer, Cham.

Herranz, E., Colomo-Palacios, R., & de Amescua Seco, A. (2015, September). *Gamiware: a gamification platform for software process improvement.* In European Conference on Software Process Improvement (pp. 127-139). Springer, Cham.

Mademtzi, M. (2016). *The use of a kinect-based technology within the school environment to enhance sensory-motor skills of children with autism* (Doctoral dissertation, University of Birmingham).

Mehregan, M.R. (2004). *Advance operational research.* 1st ed., Acadmic Books Pub.

Muchran, M., Syamsiah, B., Arifin, I., Paisal, H. (2020). The Phenomenon of Women Entrepreneurship and its Contribution to the Supply Chain Promotion: A case of Indonesian Supply Chain Companies. *International Journal of Supply Chain Management (IJSCM), 9*(1), 113-120.

Robert Werling, Sriram Chintakrindi, Nicholas Clark, Gregory Morris, Mark Perry, Blake Randol, Citizen Opinion Survey: How a Mid-Sized California Community Perceives their Police Department - International Journal of Criminology and Sociology, 7, 2018, 239-249, DOI: https://doi.org/10.6000/1929-4409.2018.07.17

Simchenko, N., Tsohla, S., & Podsmashnaya, I. (2016). Application of the analytic hierarchy process to structure the motivational expectations of the economically active population of the Republic of Crimea. *Journal of Applied Economic Sciences Open Access, 8*(46), 1569-1580.