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Thesis Paper on-

"Technological Assessment of Internet Access Media: Bangladesh perspective"

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DECLARATION

This research report entitled "Technological Assessment of Internet Access Medium: Bangladesh perspective" presented to the department of Electronics and Communications Engineering, East West University has been accepted as satisfactory for the partial fulfillment of the requirement for degree of B.Sc. Engineering degree under the supervision of Dr. M. Mofazzal Hossain, Professor, Department of ECE, East West University, and it has not been submitted elsewhere for any other degree.

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Dedications

To our respectable parents, who prayed for our success and supported us morally and financially

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We are grateful to the Almighty for the good health and wellbeing that were necessary to complete this book. We do pray to His Greatness to inspire and enable us to continue the work for the benefits of humanity.

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ABSTRACT

The object of this research is Technological Assessment of Internet Access Media in the perspective of Bangladesh. The Fuzzy AHP technology assessment tool is used for this purpose. For Fuzzy analytical hierarchy process (Fuzzy AHP) analysis, we have considered seven main attributes/criteria: Technical Factor (TF), Environment Factor (EVF), Economic Factor (EF), Mobility Factor (MF), Population Factor (POPF), Connection reliability Factor (CRF), and Running Cost (RC), and five main factors : Coaxial Cable , Optical Fiber, Wimax, 3G, and 4G.

In this study, with the Fuzzy AHP tool, based on expert opinion data it is found that the Optical Fiber has got top ranking and 28.3% preference, almost equally preferred of 4G with 2^{nd} position in ranking which is 19.8% preferable. The 3^{rd} rank is 3G and it is 19.5% preferable, Wimax and Coaxial Cable has got 4^{th} and 5^{th} rank with 17.2% preference and 16.4% preference respectively. Based on the result of this research it would be suggested that Optical Fiber has the highest preference.

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Nomenclature

Table 1: Nomenclature

Abbreviation	Full Meaning
TF	Technical Factor
EVF	Environment Factor
EF	Economic Factor
MF	Mobility Factor
POPF	Population Factor
CRF	Connection reliability Factor
RC	Running Cost
COC	Coaxial Cable
OPF	Optical Fiber
W	Wimax
3G	Third Generation
4G	Fourth Generation

Chapter I

Introduction

1.1 Background

Information and Communication Technology (ICT) plays an increasingly greater role in the development of nations. The internet profoundly affects the lives of billions of people. The 2016 World Development Report will ask whether it is also a force for development. The Report will explore the internet's impact on economic growth, on social and economic opportunities, and on the efficiency of public service delivery. It will analyze the factors that have allowed some businesses, people, and governments to benefit greatly from the internet, and others not to benefit [1].The poor connectivity of Internet in the least developed countries is one of the major factors underlying the digital divide between the developed and developing nations. In Bangladesh, the usage of internet and multimedia by government, corporate and public sectors and individual increasingly changed. The Internet's speed in Bangladesh is not among the fastest in the world but it has significantly developed in the recent past. As of April 2014, Bangladesh ranked 138th out of 190 countries on the Household Download Index by Net Index [2]. The governments of many countries have promoted the usage of internet access media as well as related technology in the belief that internet access media will contribute to economic and social development by enhancing productivity and introducing new service in the long term. Though internet access media is available, the cost of high speed connection is higher than in other south Asian countries, Internet access media in Bangladesh is slowly progressing. It's a generic term to describe high-speed networking services which is a set of digital communication technologies with the capacity to transmit significant amounts of data at a high rate, supporting the delivery of a range of digital services some or all of which can occur simultaneously. To make a digital society must need appropriate internet access media. In spite of the overall rapid growth internet access media diffusion, as a developing country Bangladesh is still in the early stage of internet access media development and despite the presence of online Internet service, its scope is largely underutilized. Early stage of technology transfer the customer satisfaction is very important for faster diffusion.

1.2 Data Validation

The collected data from the experts have been validated through cross checking and the consistency of each matrix has been checked. If the collected data of someone was found inconsistent, the data has been collected again and again until the matrix was found consistence.

1.3 Contribution of the thesis

The purpose of this study is to develop a scientific framework for priority ranking of different Internet access media to increase the Broadband services by suitable methods in Bangladesh. The contributions of the thesis are as follows:

- Technology assessment is an important component for effective technology management (TM). This is truer in developing countries. This research is a small imitative for TA of Internet access media for Bangladesh, by using the advanced technology Assessment tool, Fuzzy Analytical Hierarchical Process.
- In this study it is tried to find out the requirement specification for an MCDM based energy modeling framework with following features:
  - Easy to use with transparent logic
  - Able to elicit and aggregate the expert's preference consistently
  - Consistent handling of uncertainties or fuzziness
  - A priority ranking table of different Internet access media has been constructed
  - Results presented in a way easily understood by Decision Makers (DMs)
- Finally, According to the priority rank of different Internet access media by this empirical research which has less fuzziness or closer to reality, the DMs may consider about which type of internet access media will be given importance at what level for the action plan of Internet access media in the economic, environmental context of Bangladesh.

1.4 Scope and Limitation of the Study

Scope

This research wants to focus on the priority ranking of COC, OPF, W, 3G and 4G in the perspective of Bangladesh. Consider related attributes by Fuzzy AHP tool. This research is to describe the importance or preference of different Internet access media like COC, OPF, W, 3G, and 4G. With some specific scale or percentage which is easily understood by DMs.

For constructing the Fuzzy reciprocal matrix, we have used expert opinion to get more accurate/reliable result. Mathematical operations have been conducted to find out the global weight of different Internet access media in the perspective of Bangladesh.

Limitations

In This empirical research, Fuzzy AHP analysis is applied mainly for ranking of different Internet access media. This method also excluded to reduce the complexity of expert's pair - wise comparison matrix, complex mathematical calculation.

Moreover, the priority rank is calculated on the judgmental opinion of experts, in this case the refinement / accuracy of the ranking also depends on the foresightedness and thoroughness of the experts.

Chapter II

Internet Medium Technology

2.1 Assessment of Internet Technology

2.1.1 Coaxial Cable

Broadband coaxial cable communications system that use broadband networking techniques on coaxial cable. The 300 megahertz (MHz) bandwidth of a coaxial cable is divided into multiple channels through frequency division multiplexing. A broadband coaxial cable can transmit many simultaneous signals using different frequencies. Broadband coaxial cable supports the frequency range above 4 kHz and is used for analog signals. So it must be used with a modem [3].

2.1.2 Optical Fiber

Cable broadband uses special fiber-optic cables to deliver internet connections far faster than traditional copper phone line cables. The signals travel significantly faster and so internet connections can reach super-fast speeds of 300Mbps in some areas. Most cable connections can provide a speed of up to 76mbps. These connections are known as fiber to the exchange connections as they offer fiber-optic connections to your local junction box. Standard copper cabling then connects your home to the fiber-optic network. In some areas you may be fortunate to receive a direct Fiber to the Home (FTTH) which means cable broadband runs directly into your home – providing speeds of up to 300Mbps.

The benefits of cable broadband is

- Cable broadband is incredibly fast thanks to fiber-optic cable technology.
- You can receive fantastic packages including cable TV, phone and internet ready technology. Super-fast connection speeds of up to 300Mbps [4]

2.1.3 Wimax

While it operates using many of the same fundamental principles as Wi-Fi networks, it offers a far greater signal range than the 100 feet provided by most conventional Wi-Fi modems. Instead, WiMAX boasts a 30 mile radius, large enough to cover portions of major cities. In addition, this standard is intended to provide 30 to 40 megabits per second as a transfer rate, with a 2011 update to the standard yielding up to 1 gigabit per second at fixed points. It should be noted, however, that bandwidth on a WiMAX network is not exclusive to users and instead must be split, meaning that while higher speeds may be advertised, the number of users can lower transfer rates in practice[5]

WiMAX uses IEEE 802.16 wireless network standards that are interoperable, as compared to the IEEE 802.11 standards used by wireless LANs. The original standard, as mentioned above, was developed in 2001 and borrowed some of its technology from a service known as Wipro, used in South Korea. This standard is sometimes referred to as “Wi-Fi on steroids” for its ability to far outperform Wi-Fi transfer rates and signal distance, and gained significant ground in the market with the deployment of Mobile WiMAX, based on 802.16e-2005, and which led to the 802.16e-2011 revision and higher data transfer rates. WiMAX has a number of front-line uses, including at-home and mobile Internet access. Because of its large radius and relatively low cost to implement when compared to 3G, xDSL or HFC, the technology can not only compete in a local market but also be used for last-mile access in remote locations. In addition, the standard can be used as backbone for cellular technology, either by replacing current technologies or acting as an overlay in order to increase capacity [6].

2.1.4 3G Technology

3G refers to the third generation of mobile telephony (that is, cellular) technology of the third generation. The International Telecommunications Union (ITU) defined the third generation (3G) of mobile telephony standards IMT-2000(International Mobile Telecommmunications-2000) to facilitate growth, increase bandwidth, and support more diverse applications. It comes with enhancements over previous wireless technologies, like high-speed transmission, advanced multimedia access and global roaming. 3G is mostly used with mobile phones and handsets as a means to connect the phone to the Internet or other IP networks in order to make voice and video calls, to download and upload data and to surf the [7].

2.1.5 4G Technology

4G is the new and improved version of 3G. Internet speeds are five times faster, and the internet connection is stronger so your internet won't suddenly slow down. There are already loads of phones available that can connect to 4G networks, while all the big new smart phones of the future will be compatible [8].

2.1.6 Comparison of 3G & 4G Technologies

Table 2.1: Here is the most important comparison of 3G and 4G [9]

Parameters	3G	4G
Data Throughput	Up to 3.1Mbps with an average speed range between 0.5 to 1.5 Mbps	Practically speaking, 2 to 12 Mbps but potential estimated at a range of 100 to 300 Mbps.
Peak Upload Rate	5 Mbps	500 Mbps
Switching Technique	packet switching	packet switching, message switching
Network Architecture	Wide Area Cell Based	Integration of wireless LAN and Wide area
Services And Applications	CDMA 2000, UMTS, EDGE etc.	Wimax2 and LTE-Advance
Forward error correction (FEC)	3G uses Turbo codes for error correction.	Concatenated codes are used for error corrections in 4G.
Peak Download Rate	100 Mbps	1 Gbps
Frequency Band	1.8 – 2.5 GHz	2 – 8 GHz

Chapter III

Theory of Fuzzy AHP

3.1Objective

The objective of this paper is to apply the extension of AHP, namely Fuzzy AHP, in order to handle the fuzziness of data involved in MCDM problem of this study. The fuzzy AHP is to make a priority ranking table regarding the customer satisfaction factors .According to the rank (1, 2, 3, 4, 5) the decision maker of Internet access media would be able to know the customer preference and formulate. The rest of this paper is organized as follows.

3.1.1History of Fuzzy Logic

When we look at the history of Fuzzy Logic, we find that the first important person for its development was Buddha. He lived in India about 500 BC and founded a religion called Buddhism. His philosophy was based on the thought that the world is filled with contradictions, that almost everything contains some of its opposite, or in other words, that things can be A- and not-A at the same time. Here we can see a clear connection between Buddha's philosophy and modern fuzzy logic [10]. In contrary to Buddha, when Aristotle and his predecessors devised their theories of logic and mathematics, they came up with the so-called Law of the Excluded Middle, which states that every proposition must either be true or false. Grass is either green or not green; it clearly cannot be both green and not green. But not everyone agreed, and Plato indicated there was a third region, beyond true and false, where these opposites "tumbled about."In the Aristotelian world view, logic dealt with two values. In the 19th century, George Boole created a system of algebra and set theory that could deal mathematically with such two-valued logic, mapping true and false to 1 and 0, respectively. Then in the early 20th century, Jan Lukasiewicz proposed a three-valued logic (true, possible, false), which never gained wide acceptance. In 1965, Lotfi A. Zadeh of the University of California at Berkeley published "Fuzzy Sets," which laid out the mathematics of fuzzy set theory and, by extension, fuzzy logic. Zadeh had observed that conventional computer logic couldn't manipulate data that represented subjective or vague ideas, so he created fuzzy logic to allow computers to determine the distinctions among data with shades of gray, similar to the process of human reasoning

[11].Some of the objections that faced fuzzy logic in its early days are shown below. Most objections to fuzzy logic have since faded due to the success of fuzzy applications.

"Fuzzy theory is wrong, wrong, and pernicious. What we need is more logical thinking, not less. The danger of fuzzy logic is that it will encourage the sort of imprecise thinking that has brought us so much trouble. **Fuzzy logic is the cocaine of science**."

-Professor William Kahan UC Berkeley

"'Fuzzification' is a kind of scientific permissiveness. It tends to result in socially appealing slogans unaccompanied by the discipline of hard scientific work and patient observation."

-Professor Rudolf KalmanUFlorida

"Fuzziness is probability in disguise. I can design a controller with probability that could do the same thing that you could do with fuzzy logic."

-Professor Myron Tribus, on hearing of the fuzzy-logic control of the Sendai subway system IEEE Institute, may 1988 [12].

Although, the technology was introduced in the U.S., U.S. and European scientist and researchers largely ignored it for years, perhaps because of its unconventional name. They refused to take seriously something that sounded so childlike. Some mathematicians argued that fuzzy logic was merely probability in disguise. But fuzzy logic was readily accepted in Japan, China and other Asian countries. The greatest number of fuzzy researchers is found today in China, with over 10,000 scientists. Japan, though considered at the leading edge of fuzzy studies, has fewer people engaged in fuzzy research. A decade ago, the Chinese University of Hong Kong surveyed consumer products using fuzzy logic, producing a 100-plus-page report listing washing machines, camcorders, microwave ovens and dozens of other kinds of electrical and electronic products [13].

3.1.2Uses of Fuzzy

The theory of fuzzy logic is based on the notion of relative graded membership, as inspired by the processes of human perception and cognition. Lotfi A. Zadeh published his first famous research paper on fuzzy sets in 1965. Fuzzy logic can deal with information arising from computational perception and cognition, that is, uncertain, imprecise, vague, partially true, or without sharp boundaries. Fuzzy logic allows for the inclusion of vague human assessments in computing problems. Also, it provides an effective means for conflict resolution of multiple criteria and better assessment of options. New computing methods based on fuzzy logic can be used in the development of intelligent systems for decision making, identification, pattern recognition, optimization, and control.

Fuzzy logic is extremely useful for many people involved in research and development including engineers (electrical, mechanical, civil, chemical, aerospace, agricultural, biomedical, computer, environmental, geological, industrial, and mechatronics), mathematicians, computer software developers and researchers, natural scientists (biology, chemistry, earth science, and physics), medical researchers, social scientists (economics, management, political science, and psychology), public policy analysts, business analysts, and jurists.

Indeed, the applications of fuzzy logic, once thought to be an obscure mathematical curiosity, can be found in many engineering and scientific works. Fuzzy logic has been used in numerous applications such as facial pattern recognition, air conditioners, washing machines, vacuum cleaners, antiskid braking systems, transmission systems, control of subway systems and unmanned helicopters, knowledge-based systems for multi objective optimization of power systems, weather forecasting systems, models for new product pricing or project risk assessment, medical diagnosis and treatment plans, and stock trading. Fuzzy logic has been successfully used in numerous fields such as control systems engineering, image processing, power engineering, industrial automation, robotics, consumer electronics, and optimization. This branch of mathematics has instilled new life into scientific fields that have been dormant for a long time. Thousands of researchers is working with fuzzy logic and producing patents and research papers. According to Zadeh's report on the impact of fuzzy logic as of March 4, 2013, there are 26 research journals on theory or applications of fuzzy logic, there are 89,365 publications on theory or applications of fuzzy logic in the INSPEC database, there are 22,657 publications on theory or applications of fuzzy logic in the Math SciNet database, there are 16,898 patent applications and patents issued related to fuzzy logic in the USA, and there are 7149 patent applications and patents issued related to fuzzy logic in Japan. The number of research contributions is growing daily and is growing at an increasing rate. Zadeh started the Berkeley Initiative in Soft

Computing (BISC), a famous research laboratory at University of California, Berkeley, to advance theory and applications of fuzzy logic and soft computing [14].The journal welcomes original and significant contributions in the area of Fuzzy Sets whether on empirical or mathematical foundations, or their applications to any domain of information technology, and more generally to any field of investigation where fuzzy sets are relevant. Applied papers demonstrating the usefulness of **fuzzy methodology** in practical problems are particularly welcome. *Fuzzy Sets and Systems* publishes high-quality research articles, surveys as well as case studies. Separate sections are Recent Literature, and the Bulletin, which offers research reports, book reviews and conference announcements and various news items. Invited review articles on topics of general interest are included and special issues are published regularly [15].

3.1.3Why Fuzzy Logic

- Fuzzy logic is conceptually easy to understand.

The mathematical concepts behind fuzzy reasoning are very simple. What makes fuzzy nice is the "naturalness" of its approach and not its far-reaching complexity.

- Fuzzy logic is flexible.

With any given system, it's easy to massage it or layer more functionality on top of it without starting again from scratch.

- Fuzzy logic is tolerant of imprecise data.

Everything is imprecise if you look closely enough, but more than that, most things are imprecise even on careful inspection. Fuzzy reasoning builds this understanding into the process rather than tacking it onto the end.

- Fuzzy logic can model nonlinear functions of arbitrary complexity.

You can create a fuzzy system to match any set of input-output data. This process is made particularly easy by adaptive techniques like ANFIS (Adaptive Nero-Fuzzy Inference Systems), which are available in the Fuzzy Logic Toolbox.

- Fuzzy logic can be built on top of the experience of experts.

In direct contrast to neural networks, which take training data and generate opaque, impenetrable models, fuzzy logic lets you rely on the experience of people who already understand your system.

- Fuzzy logic can be blended with conventional control techniques.

Fuzzy systems don't necessarily replace conventional control methods. In many cases fuzzy systems augment them and simplify their implementation.

- Fuzzy logic is based on natural language.
- The basis for fuzzy logic is the basis for human communication. This observation underpins many of the other statements about fuzzy logic [16].

3.1.4Advantagesand Disadvantages of the Use of Fuzzy Systems

The key idea of using fuzzy logic however is that precision is expensive while not always necessary. People for instance are quite good at performing several decision tasks using only no precise data and generating no precise actions. One of the key reasons why fuzzy logic works well is the fact that many systems do not require very critical tuning. In other words, when parameters are set sub-optimal, the performance will not degrade very much. Summarizing, the following benefits can be named:

- Fuzzy Logic describes systems in terms of a combination of numeric's and linguistics (symbolic). This has advantages over pure mathematical (numerical) approaches or pure symbolic approaches because very often system knowledge is available in such a combination.
- Problems for which an exact mathematically precise description is lacking or is only available for very restricted conditions can often be tackled by fuzzy logic, provided a fuzzy model is present.
- Fuzzy logic sometimes uses only approximate data, so simple sensors can be used.
- The algorithms can be described with little data, so little memory is required.
- The algorithms are often quite understandable.

- Fuzzy algorithms are often robust, in the sense that they are not very sensitive to changing environments and erroneous or forgotten rules.
- The reasoning process is often simple, compared to computationally precise systems, so computing power is saved this is a very interesting feature, especially in real time systems.
- Fuzzy methods usually have a shorter development time than conventional methods. Although the above named advantages are very promising, one must be aware that fuzzy logic does not fit to every problem.

The following remarks must be made:

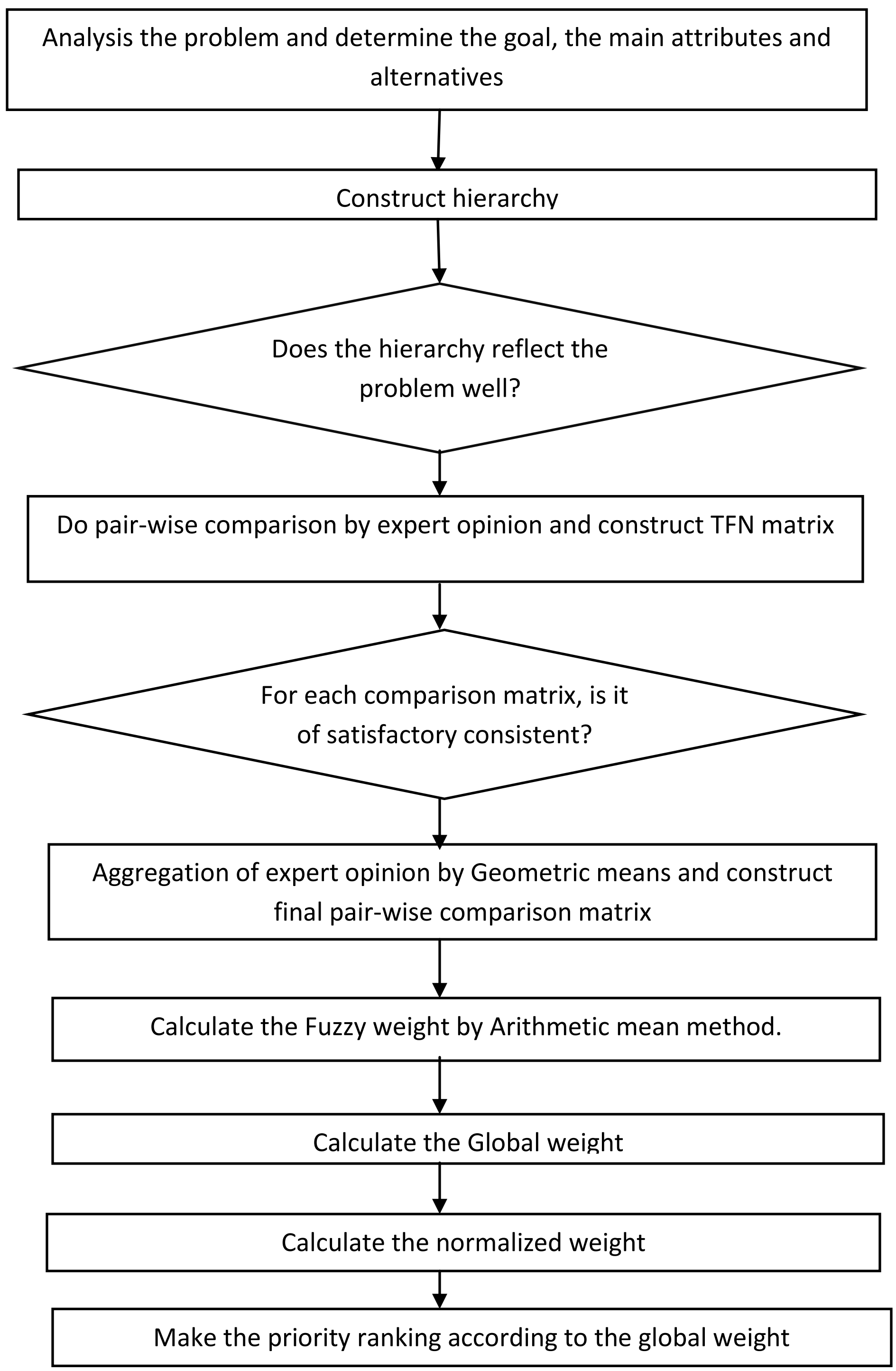
- Fuzzy logic amounts to function approximation in the case of Crisp-Input/Crisp-Output systems. This means that in many cases, using fuzzy logic is just a different way of performing interposition In the light of the fact that system knowledge is often available as a combination of numeric’s (quantitative) and linguistics (quantitative or qualitative) this approach may even be advantageous.
- In areas that have good mathematical descriptions and solutions, the use of fuzzy logic most often may be sensible when computing power (i.e. time and memory) restrictions are too severe for a complete mathematical implementation.
- I am convinced that results obtained in successful fuzzy application,: that are given in literature can be reached with a conventional approach as well, possibly taking longer development time and possibly with the use of different interpolation methods. Careful analysis of comparison examples, 'proving' the superiority of fuzzy logic often shows that they compare the fuzz) approach with a very simple, non-optimized conventional approach.
- Proof of characteristics of fuzzy systems is difficult* or impossible in most cases because of lacking mathematical descriptions; especially in the area of stability of control systems this is an important research item. On the other hand, when solving practical problems, this is often not a very severe restriction because when the system is tested the characteristics will also be found [17].

Chapter IV

Fuzzy AHP Methodology

4.1.1Construct the Algorithm flow chart for Fuzzy AHP

First of all, the fuzzy AHP algorithm is developed which is given in Figure 4.1



4.1.2Fuzzy Set and Fuzzy Triangular Number

The notion of a fuzzy set stems from the observation made by Zadeh (1965a) that "more often than not, the classes of objects encountered in the real physical world do not have precisely defined criteria of membership". This observation emphasizes the gap existing between mental representations of reality and usual mathematical representations thereof, which are based on binary logic, precise numbers, differential equations and the like. Classes of objects referred to in Zadeh's citation exist only through such mental representations through natural language terms such as high temperature, young man, big size, etc., and also with nouns such as bird, chair, etc. Classical logic is too rigid to account for such categories where it appears that membership is a gradual notion rather than an all-or-nothing matter. The power of expressivity of real numbers is far beyond the limited level of precision found in mental representations. The latter are meaningful summaries of perceptive phenomena's that account for the complexity of the world. Analytical representations of physical phenomena can be faithful as models of reality, but are sometimes difficult to understand because they do not explain much by themselves, and may remain opaque to the non-specialist. Mental representations make more sense but are pervaded with vagueness, which encompasses at the same time the lack of specificity of linguistic terms, and the lack of well-defined boundaries of the class of objects they refer to. We shall then speak of fuzzy predicates, or gradual properties. The ambition of representing human knowledge in a human-friendly, yet rigorous way might have appeared like a futile exercise not worth spending time on, and even ridiculous from a scientific standpoint, one hundred years ago. However in the meantime the emergence of computers has significantly affected the landscape of science, and we have now entered the era of information management. The development of sound theories and efficient technology for knowledge representation and automated reasoning has become a major challenge, now that many people possess computers and communicate with them in order to find information that helps them when making decisions. An important issue is to store and exploit human knowledge in various domains where little objective and precise data are available. Fuzzy set theory participates to this trend (Dubois, Prade and Yager, 1997), and, as such, has close connection with Artificial Intelligence. Many attempts have been made, especially in this century, for augmenting the representational capabilities of logic, or for proposing non-additive models of uncertainty. One of the most radical and fruitful of these attempts was initiated by LotfiZadeh in 1965 with the publication of his paper "Fuzzy Sets." Starting from the idea of gradual membership, it has been the basis for both a logic of gradualness in properties and a new, particularly simple and effective, uncertainty calculus, called "Possibility Theory" by Zadeh (1978a), for handling the notions of possibility and certainty (or necessity) as gradual modalities. When proposing fuzzy sets, Zadeh's concerns were explicitly centered on their potential contribution in the domains of pattern classification (Bellman et al., 1966), processing and communication of information, abstraction and summarization (Zadeh, 1973). Although the claims that fuzzy sets were relevant in these areas appeared unsustained at the time when they were first uttered, namely in the early sixties, the future development of information sciences and engineering proved that these intuitions were right, beyond all expectations. In the literature of fuzzy sets, the word fuzzy often stands for the word vague. Some comment on the links between vagueness and fuzziness is useful. In common use, there is a property of objects called "fuzziness"; see also Rolf (1980). From the Oxford English Dictionary we read that "fuzzy" means either not firm or sound in substance, or fringed into loose fibers. Fuzzy means also covered by fuzz, i.e., with loose volatile matter. Alike any other characteristic, "fuzzy" can be used to form a predicate of the form: "something is fuzzy". For example "a bear is fuzzy". It may sound strange to say that "bald is fuzzy", or that "young is fuzzy". Words (adjectives in this case) bald and young are vague (but not fuzzy in the material sense) because their meanings are not fixed by sharp boundaries. Similarly, objects are not vague.Here however; the word "fuzzy" is applied to words, especially predicates, and is supposed to refer to the gradual nature of some of these words, which causes them to appear as vague. However, the term "vagueness" designates a much larger kind of ill-definition for words (including ambiguity), generally. The specificity of fuzzy sets is to capture the idea of partial membership. The characteristic function of a fuzzy set, often called membership function, is a function whose range is an ordered membership set containing more than two (often a continuum of) values (typically, the unit interval). Therefore, a fuzzy set is often understood as a function. This has been a source of criticism from mathematicians (Arbib, 1977) as functions are already well-known, and a theory of functions already exists. However, the novelty of fuzzy set theory, as first proposed by Zadeh, is to treat functions as if they were subsets of their domains, since such functions are used to represent gradual categories. It means that classical set-theoretic notions like intersection, union, complement, inclusion, etc. are extended so as to combine functions ranging on an ordered membership set. In elementary fuzzy set theory, the set-union of functions is performed by taking their point wise maximum, their intersection by their point wise minimum, their complementation by means of an order-reversing auto Orphism of the membership scale, and set-inclusion by the point wise inequality between functions. This point of view had not been envisaged earlier by mathematicians, if we except some pioneers, mainly logicians. Fuzzy set theory is indeed closely connected to many-valued logics that appeared in the thirties, if degrees of membership are understood as degrees of truth, intersection as conjunction, union as disjunction, complementation as negation and set-inclusion as implication. This Chapter is meant to account for the history of how the notion of fuzzy sets could come to light, and it also presents a catalogue of basic notions which are presented in greater details as well as in the other volumes of the Handbooks of Fuzzy Sets Series.shows that the problem of representing vagueness in logic, in physics, in linguistics, as well as the questioning of the notion of set in the twentieth century led to preliminary proposals that came close to fuzzy set theory. They make its emergence retrospectively less surprising, if not expected. It is a way to show that fuzzy set theory is not a strange, gratuitous object that suddenly appeared out of nothing, but that it crystallized the intuitions of some leading scientists in the century. Presents various ways of representing a fuzzy set and provides the basic set theoretic connectives as well as counterparts of various set-theoretic notions such as cardinality, inclusion and the like. It describes canonical tools for extending many mathematical notions to fuzzy sets. It also introduces special types of fuzzy sets useful in applications, like convex fuzzy sets, a noticeable example being fuzzy intervals. Overviews offspring's of the notion of a fuzzy set that have been developed further on for their own sake, such as fuzzy relations, and set functions for which fuzzy sets play the role of density. a repertory of variants of fuzzy sets found in the literature, where the membership function is changed into more elementary entities (a mere ordering relation, for instance), or more complex entities (for instance, when membership grades become functions themselves). It also describes some types of non-classical sets that have common features with, although different from, fuzzy sets. Finally Indeed a set is a very abstract notion, and it is very difficult to use pure set-theoretic intuitions in order to build membership functions in practice. The most popular interpretations of fuzzy sets in terms of similarity, uncertainty and preference profiles are reviewed. These concrete views of membership functions are those found in the current practice of fuzzy set-based methods in applications [18].

The concept of fuzzy logic must be used to describe actual things and to compensate for the failings of traditional theory sets that use only binary logic to describe things. Fuzzy logic used to concept of membership function to describe things in a manner similar to common human language. Furthermore, fuzzy logic can analyze ambiguity and vagueness.

The fuzzy set can be defined as follows:

$\tilde{A} = \{((x, \mu\tilde{A}\ (x|)) \quad x \in U)\}$…….(1)

Where $\tilde{A}$ is a fuzzy set . $\mu\tilde{A}$ (x) is called the membership function . U is the universe of discourse. $\mu\tilde{A}$ (x) ranges between 0 and 1 . This is called the degree of membership and the equation (2) expresses its membership function .

$\mu_{\tilde{A}} = \{x\text{-}c/a\text{-}c,\ c \leq x \leq a$

$\{x\text{-}b/a\text{-}b,\ a \leq x \leq b$ ………. (2)

$\{0,\text{otherwise}$

Where $a \leq b \leq c$. if a = b = c, the fuzzy number gets a crisp value. Here a,b,c and c are the lowest possible value, the most possible value, and the largest possible value respectively . A TFN is represented as (a, b, c) as illustrated in fig. 2 [19].

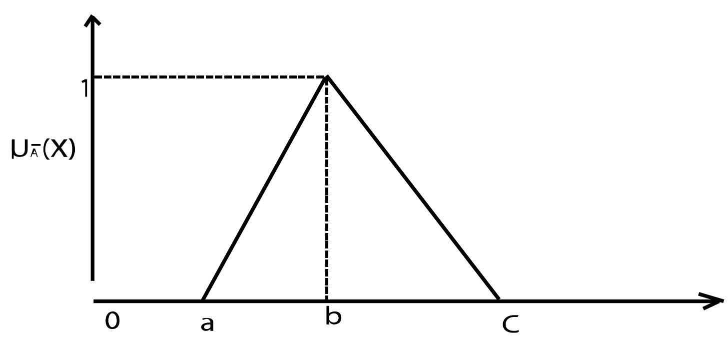


Figure 4.2 Fuzzy TFN

4.1.3Determine the Attributes

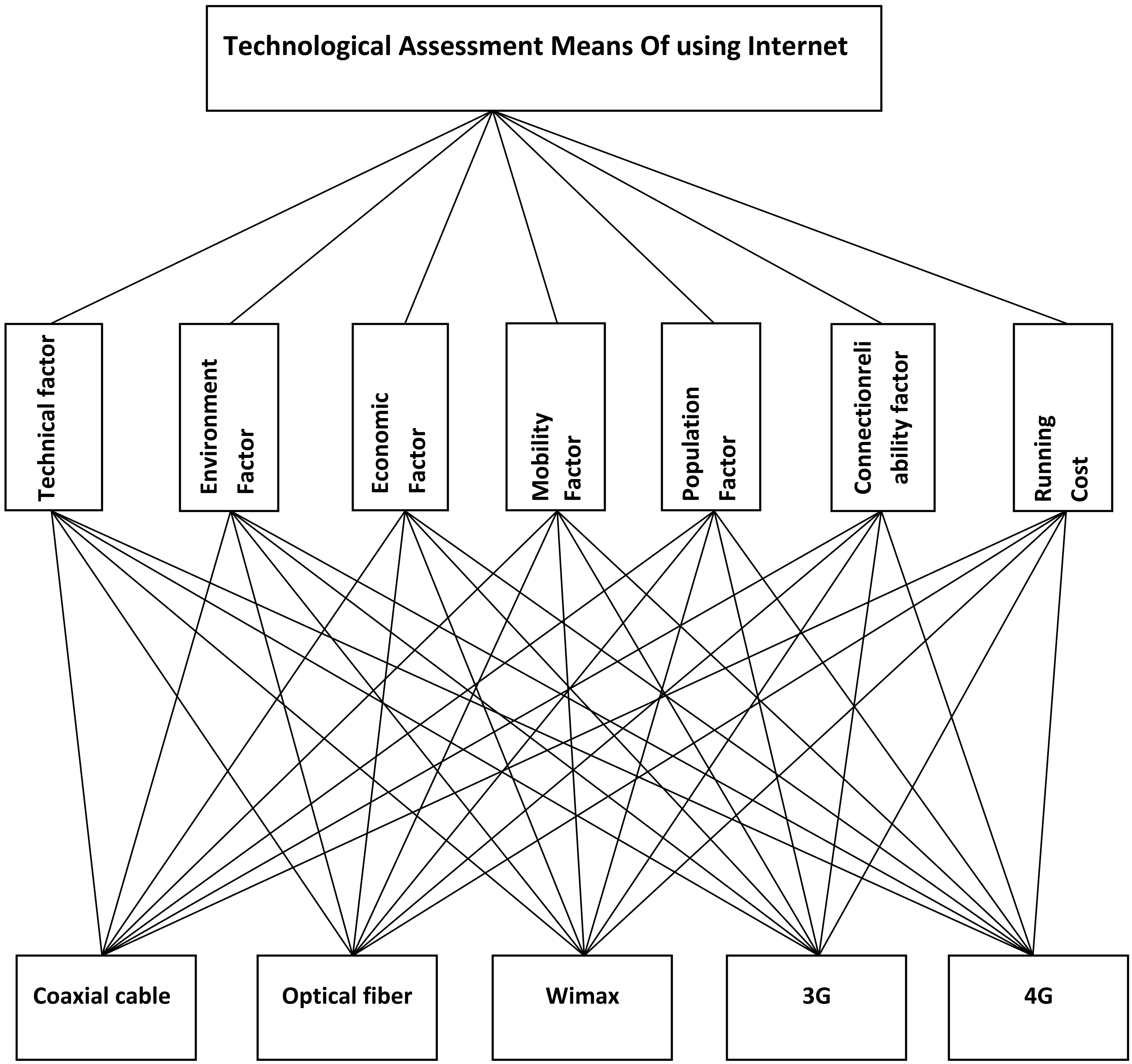
The attributes/factors which give the customer satisfaction are determined by Delphi Technique. The expert panel for the Delphi Technique was:

Table4.1: Expert panel for Delphi.

Number	Gender	Position	Organization	Age (years)	Experience (years)	Academic Degree	Skill in Relevant Sector
1	Male	Professor	Public University	>45	Over 20	PhD	Very Much
2	Male	Associate Professor	Public University	>40	Over 17	PhD	Much
3	Male	Divisional Engineer	BTCL	>45	Over 18	B.Sc.Engg	Very Much
4	Male	Manager	GP	>45	Over 18	B.Sc.Engg	Much
5	Male	Manager	Teletalk	>40	Over 15	B.Sc.Engg	Much

4.1.4Establish the Hierarchical Structure

The hierarchical decomposition of simple one is given in fig.4.3.



4.1.5 Selection of pair-wise comparison scale

For making the pair-wise comparison matrix, in this study the following scale is used.

Table 4.2: Triangular Scale for Triangular Fuzzy number (TFN) conversion (Büyüközkan et. 2004) [20]

Linguistic scale	Fuzzy triangular scale	Reciprocal Fuzzy Triangular scale
Just Equal	(1, 1, 1)	(1, 1, 1)
Equal Important	(1/2 , 1 , 3/2)	(2/3 , 1, 2)
Weakly more important	(1, 3/2, 2)	(1/2 , 2/3 , 1)
Strongly more important	(3/2 , 2 , 5/2)	(2/5, 1/2, 2/3)
Very strongly more important	(2, 5/2 , 3)	(1/3 , 2/5 , 1/2)
Absolutely more important	(5/2 , 3, 7/2)	(2/7, 1/3, 2/5)

Table 4.3: Satyr (1977) calculated the random indices [21].

N	3	4	5	6	7	8	9	10
RI	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

4.1.6Construction of Questionnaire

Please read the following questions and put check marks on the pair wise comparison matrices.

- If the attribute of 'LHS' is more important/preferable than the right side (RHS) attribute with respect to the element on which it is compared, then use proper scale of left hand side

- If the attribute of 'RHS' is more important/preferable than the left hand side (LHS) attribute with respect to the element on which it is compared, then use proper scale of right hand side.

A. To ensure minimum cost reliable and environment friendly internet connection in Bangladesh perspective.

1. How important / preferable is Technical Factor (TF) when it is compared with Environment Factor?
2. How important / preferable is Technical Factor (TF) when it is compared with Economic Factor?
3. How important / preferable is Technical Factor (TF) when it is compared with Mobility Factor?
4. How important / preferable is Technical Factor (TF) when it is compared with Population Factor?
5. How important / preferable is Technical Factor (TF) when it is compared with Connection reliability Factor?
6. How important / preferable is Technical Factor (TF) when it is compared with Running cost Factor?
7. How important / preferable is Environment Factor (EVF) when it is compared with Economic Factor?
8. How important / preferable is Environment Factor (EVF) when it is compared with Mobility Factor?
9. How important / preferable is Environment Factor (EVF) when it is compared with Population Factor?
10. How important / preferable is Environment Factor (EVF) when it is compared with Connection reliability Factor?
11. How important / preferable is Environment Factor (EVF) when it is compared with Running Cost Factor?
12. How important / preferable is Economic Factor (EF) when it is compared with Mobility Factor?
13. How important / preferable is Economic Factor (EF) when it is compared with Population Factor?
14. How important / preferable is Economic Factor (EF) when it is compared with Connection reliability Factor?
15. How important / preferable is Economic Factor (EF) when it is compared with Running Cost Factor?
16. How important / preferable is Mobility Factor (MF) when it is compared with Population Factor?
17. How important / preferable is Mobility Factor (MF) when it is compared with Connection reliability Factor?
18. How important / preferable is Mobility Factor (MF) when it is compared with Running cost Factor?

19. How important / preferable is Population Factor (POF) when it is compared with Connection reliability Factor?
20. How important / preferable is Population Factor (POF) when it is compared with Running cost Factor?
21. How important / preferable is Connection reliability Factor (CRF) when it is compared with Running cost Factor?

With respect to over goal		Importance of one main attribute over another											
		Attribute of LHS is						Attribute of RHS is					
Question	Attribute	Absolutely more important	Very strongly more important	Strongly more important	Weakly more important	Equally important	Just Equal	Equally important	Weakly more important	Strongly more important	Very strongly more important	Absolutely more important	Attribute
Than attribute of RHS							Than attribute of LHS						
1	TF												EVF
2	TF												EF
3	TF												MF
4	TF												POPF
5	TF												CRF
6	TF												RCF
7	EVF												EF
8	EVF												MF
9	EVF												POPF
10	EVF												CRF
11	EVF												RCF
12	EF												MF

13	EF												POPF
14	EF												CRF
15	EF												RCF
16	MF												POPF
17	MF												CRF
18	MF												RCF
19	POF												CRF
20	POF												RCF
21	CRF												RCF

Similarly other questionnaire form are has been given in Appendix.

4.1.7 Description of AHP Software

USAGE: Calculation (Software): Weights of AHP (Analytic Hierarchy Process)

Function

Inputs	• Size of Pair wise Comparison Matrix • Pair wise Comparison Matrix
Outputs	• Weights (Maximum Eigen Vector) • C.I. (Consistency Index) and Eigen Value • Pair wise Comparison Matrix • Text file of above values (To use other software such as spreadsheets)

Size of Pair wise Comparison Matrix

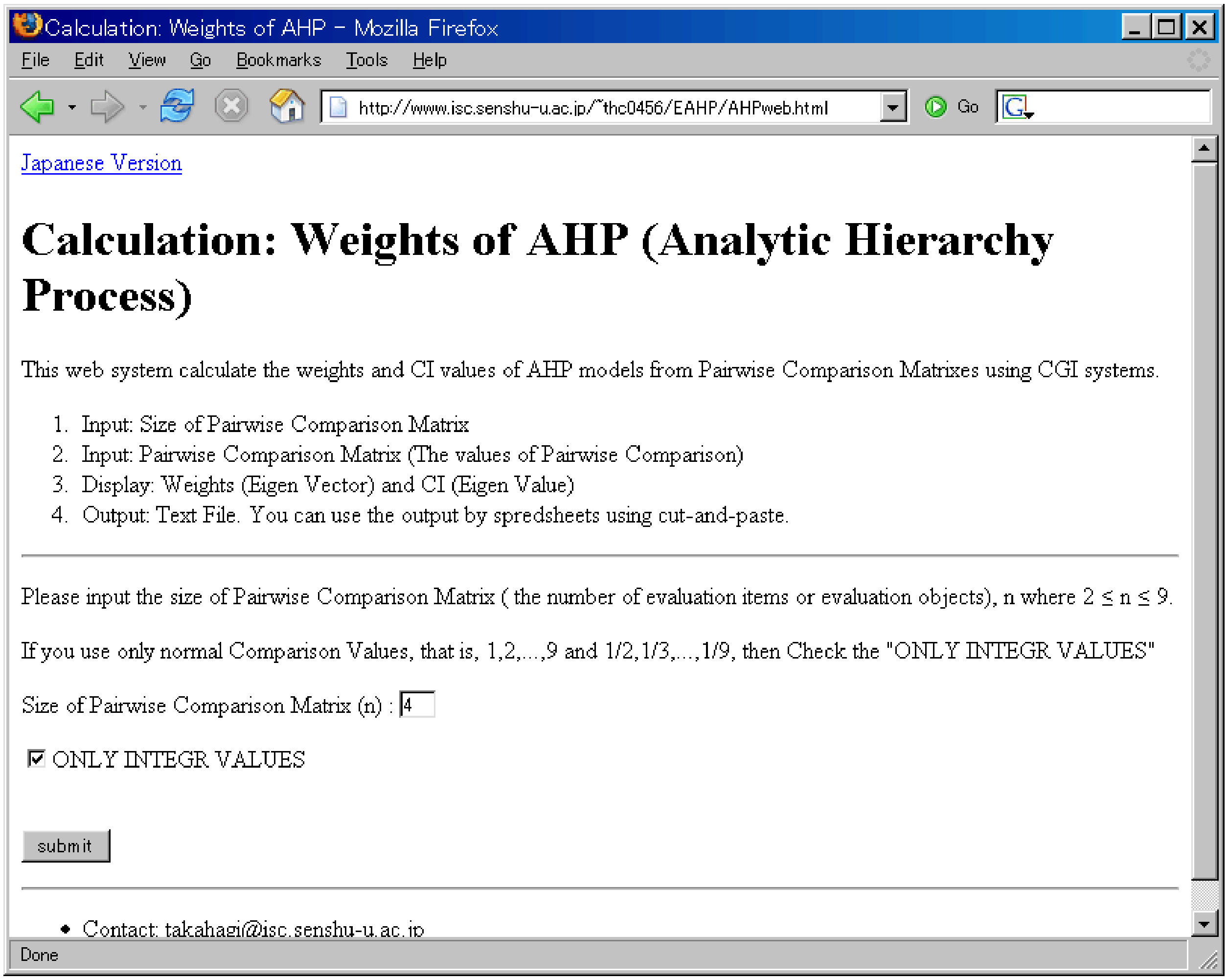


Fig.4.4: Size of Pair wise Comparison Matrix

1. Input: Size of Pair wise Comparison Matrix, n (# of Evaluation Items or Alternative) where $2 \leq n \leq 9$.
2. If you will use non-integer values in Pair wise Comparison Matrix, please take off the check box "ONLY INTEGRER VALUES"

Input: Pair wise Comparison Matrix (Only Integer Values)

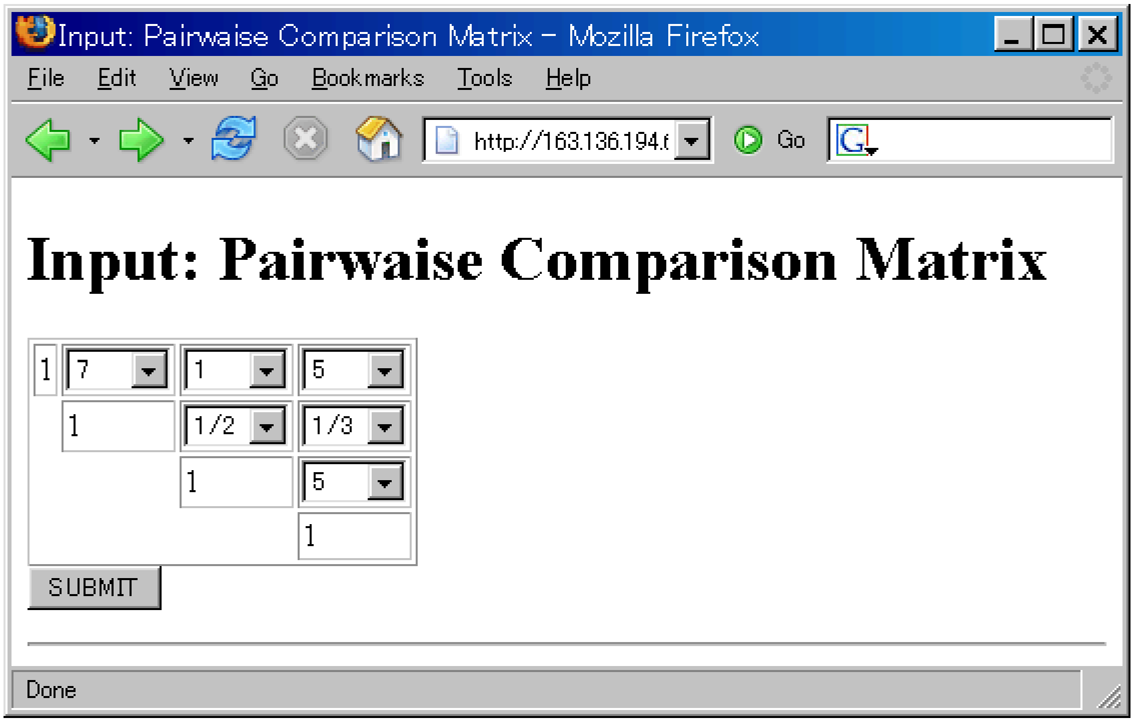
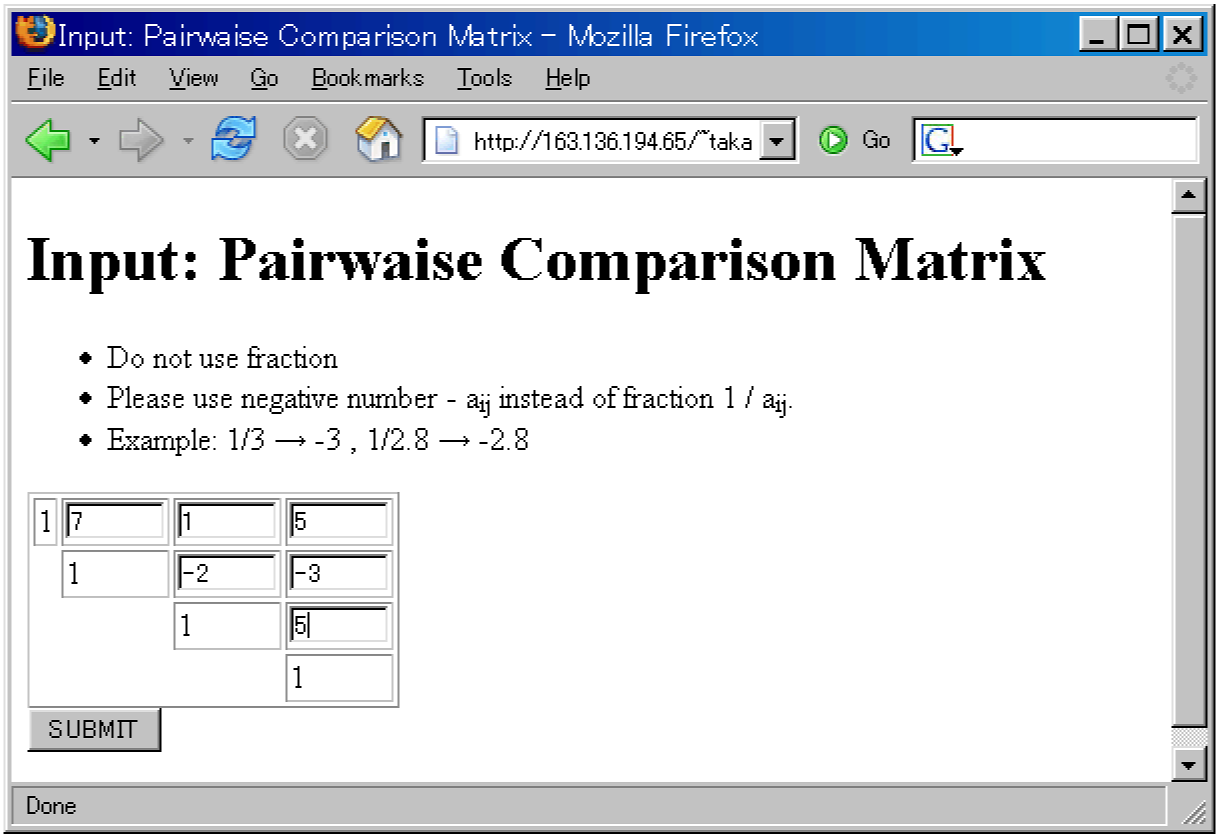


Fig.4.5 :Input: Pair wise Comparison Matrix

- Input the Pair wise Comparison Matrix

Input: Pair wise Comparison Matrix



x

Fig.4.6: Input: Pair wise Comparison Matrix

- Input the Pairwise Comparison Matrix
- Do not use fractions
- You can use negative number $-a_{ij}$ instead of fraction $1 / a_{ij}$
- Example: 1/3 → -3, 1/2.8 → -2.8

Output

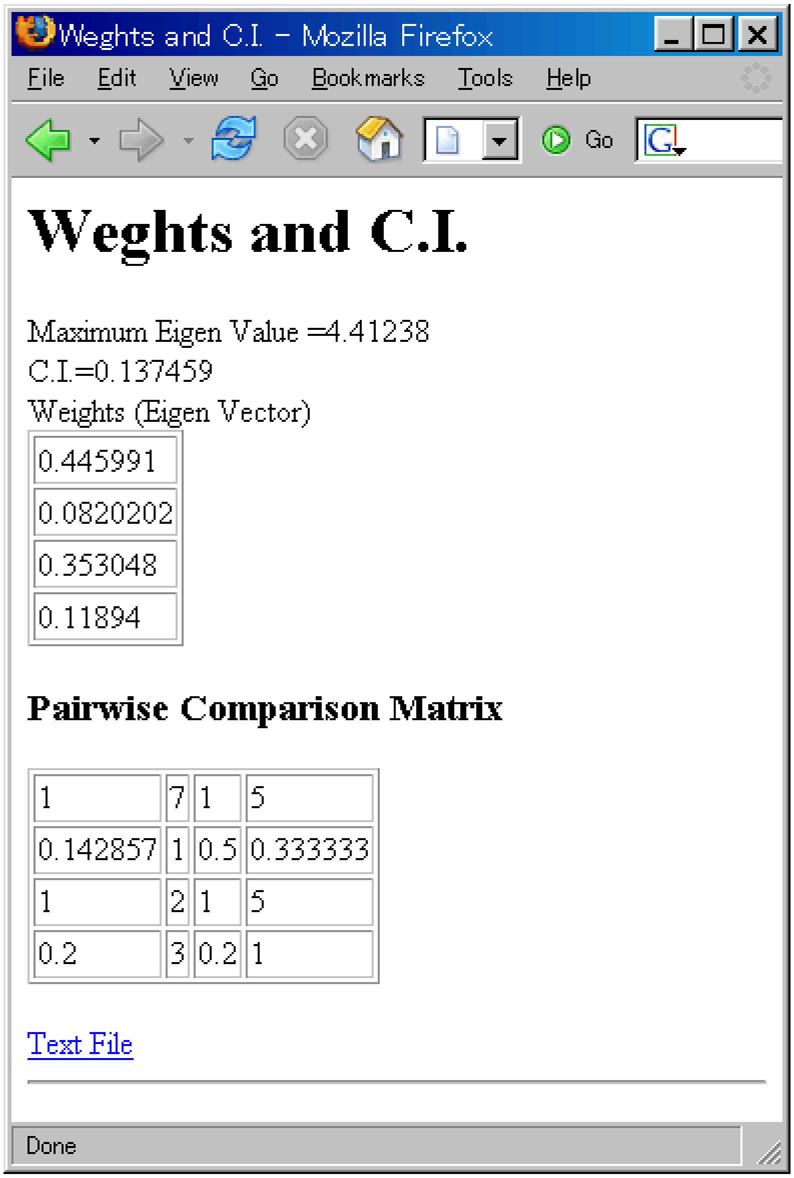


Fig.4.7: Output

- C.I. (Consistency Index): If the value is greater then 0.1 or 0.15, we recommend you to retry the Pairwise Comparison.
- Weight (Eigen Vector): Weights of Evaluation Items or Individual Scores of Alternatives
- Pairwise Comparison Matrix

Text File

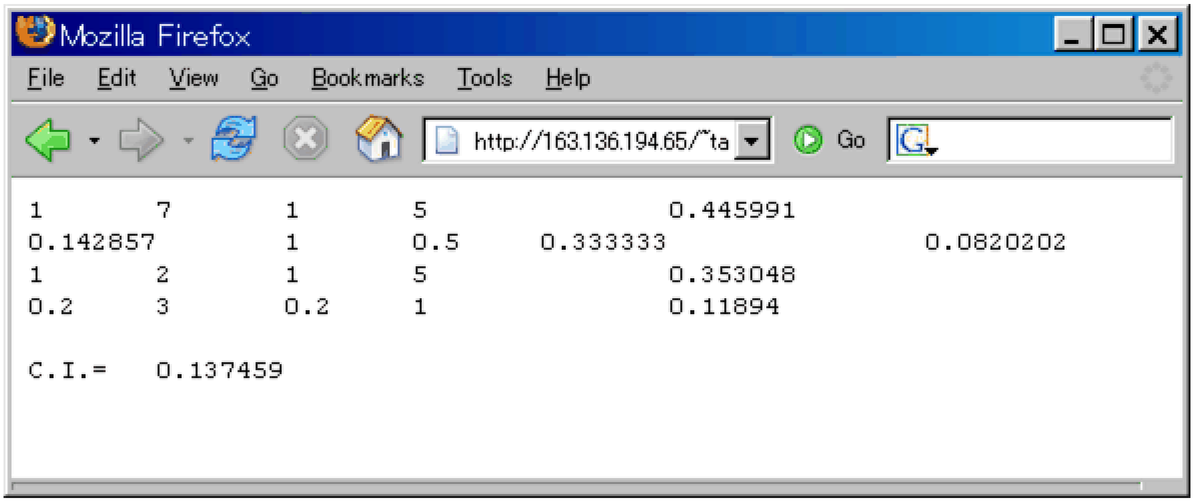


Fig.4.8: Text files

Using the text file, you can use the output for spreadsheet.
Example: Copy to Spreadsheet

- Click the link "Text File" (Fig.5.)
- Edit → select all
- Edit → Copy
- Open a spreadsheet and click the upper left cell of past area
- Edit &rarr Paste Special
- Select: Text

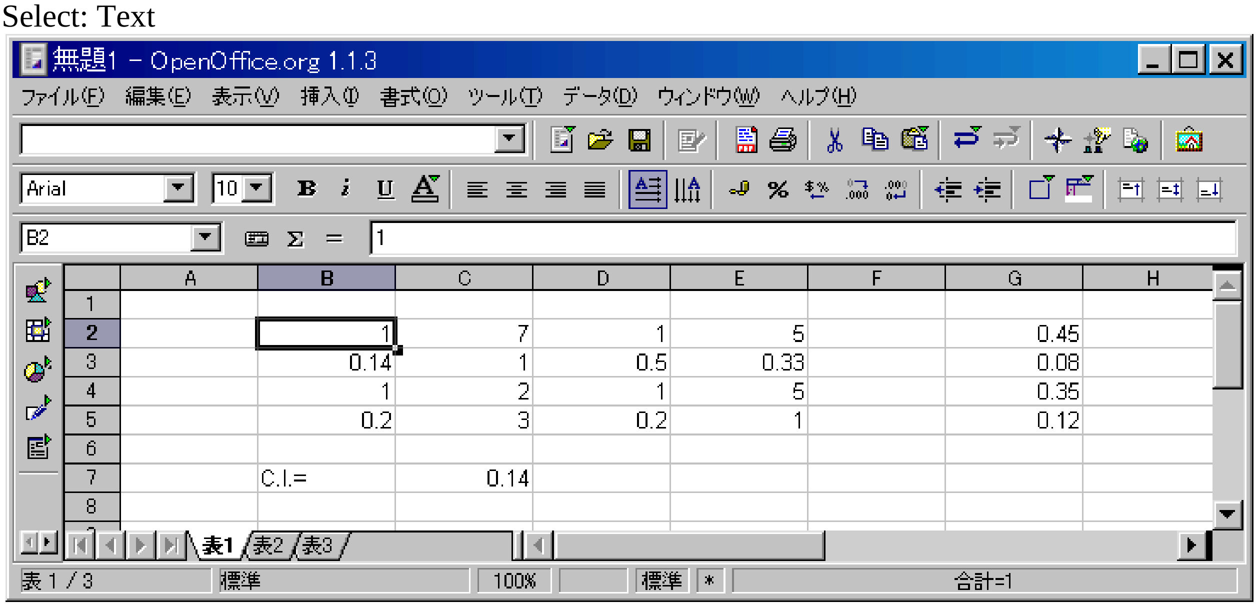


Fig. 4.9: Spredsheet (Pasted)

4.1.8 Establish a Fuzzy Positive reciprocal matrix WRT main attributes

The following Fuzzy TFN matrix (7x7) is found from the opinion of both related professional and the user (5 professional, 5 users) by a Questionnaire. The best consistence matrix is used here.

Table: 4.4 Expert 1 (Pair-wise comparison matrix for main attribute)

	TF	EVF	EF	MF	POPF	CRF	RCF
TF	1,1,1	2.0,2.5,3.0	1, 1, 1	1, 1, 1	1.5,2.0,2.5	0.5,1.0,1.5	0.4,0.5,0.66
EVF	1,1,1	1,1,1	0.4,0.5,0.66	1.0,1.5,2.0	0.5,0.66,1.0	1.5,2.0,2.5	0.4,0.5,0.66
EF	1,1,1	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	0.4,0.5,0.66	1.5,2.0,2.5	1.5, 2.0, 2.5
MF	1,1,1	0.5,0.66,1.0	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1, 1, 1	0.4,0.5,0.67
POPF	0.4,0.5,0.67	1.0,1.5,2.0	1.5, 2.0, 2.5	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1, 1, 1
CRF	0.66,1.0,2.0	0.4,0.5,0.66	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66
RCF	1.5,2.0, 2.5	1.5, 2.0, 2.5	0.4,0.5,0.66	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 7.52669, C.I. = 0.0877813

So the consistency Ratio of this Matrix CR=CI/RI= 0.0877813/1.32 = 0.066 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Similarly other form matrices for Expert 2, 3, 4, 5 are has been given in Appendix A .

4.1.9 Establish a Fuzzy Positive reciprocal matrix WRT TF

The following Fuzzy TFN matrix (5x5) is found from the opinion of both related professional and the user (5 professional, 5 users) by a Questionnaire. The best consistence matrix is used here

Table 4.5 : (Expert 1) (pair-wise comparison matrix WRT TF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.33, 0.4, 0.5	0.33,0.4,0.5	0.33,0.4,0.5	0.28,0.33,0.4
OPF	2.0, 2.5, 3.0	1,1,1	2.0, 2.5, 3.0	0.33, 0.4, 0.5	2.0, 2.5, 3.0
W	2.0,2.5, 3.0	0.33,0.4, 0.5	1,1,1	0.66, 1.0, 2.0	0.66, 1.0, 2.0
3G	2.0, 2.5, 3.0	2.0, 2.5, 3.0	0.5, 1.0, 1.5	1,1,1	1.0, 1.0, 1.0
4G	2.5, 3.0, 3.5	0.33, 0.4, 0.5	0.5, 1.0, 1.5	1.0, 1.0, 1.0	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.34157, C.I. = 0.0853922

So the consistency Ratio of this Matrix CR=CI/RI= 0.0853922/1.12= 0.0762 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Similarly other form matrices (WRT TF) for Expert 2, 3, 4, are has been given in Appendix A .

4.2.1 Establish a Fuzzy Positive reciprocal matrix WRT EVF

The following Fuzzy TFN matrix (5x5) is found from the opinion of both related professional and the user (5 professional, 5 users) by a Questionnaire. The best consistence matrix is used here

Table 4.6: (Expert 1) (pair-wise comparison matrix WRT EVF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.5,2.0, 2.5	0.4, 0.5, 0.66	1.0, 1.5, 2.0	1.0, 1.5, 2.0
OPF	0.4, 0.5, 0.67	1,1,1	1.5, 2.0, 2.5	1.5,2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.4, 0.5, 0.66	1,1,1	0.5, 1.0, 1.5	0.5, 1.0, 1.5
3G	0.5, 0.66, 1.0	0.4, 0.5, 0.67	0.66, 1.0, 2.0	1,1,1	1, 1, 1
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	0.67, 1.0, 2.0	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.44942,   C.I. = 0.112355

So the consistency Ratio of this Matrix CR=CI/RI= 0.112355/1.12= 0.1003 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Similarly other form matrices (WRT EVF) for Expert 2, 3, 4, are has been given in Appendix A

4.2.2 Establish a Fuzzy Positive reciprocal matrix WRT EF

The following Fuzzy TFN matrix (5x5) is found from the opinion of both related professional and the user (5 professional, 5 users) by a Questionnaire. The best consistence matrix is used here

Table 4.7: (Expert 1) (pair-wise comparison matrix WRT EF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33, 0.4	0.4,0.5,0.66	0.4, 0.5, 0.67	0.4, 0.5, 0.67
OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.66	0.4, 0.5, 0.61
3G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1, 1, 1
4G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.13674,   C.I. = 0.0341845

So the consistency Ratio of this Matrix CR=CI/RI= 0.0341845/1.12= 0.0305 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Similarly other form matrices (WRT EF) for Expert 2, 3, 4, are has been given in Appendix A

4.2.3 Establish a Fuzzy Positive reciprocal matrix WRT MF

The following Fuzzy TFN matrix (5x5) is found from the opinion of both related professional and the user (5 professional, 5 user) by a Questionnaire. The best consistence matrix is used here

Table 4.8: (Expert 1) (pair-wise comparison matrix WRT MF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33,0.4	1.5, 2.0, 2.5	1, 1.5, 2.0	1, 1.5, 2.0
OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	0.4, 0.5,0.66	0.4, 0.5, 0.67
3G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	0.5, 0.67, 1.0
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.27796, C.I. = 0.0694898

So the consistency Ratio of this Matrix CR=CI/RI= 0.0694898/1.12= 0.062< 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Similarly other form matrices (WRT MF) for Expert 2, 3, 4, are has been given in Appendix A

4.2.4 Establish a Fuzzy Positive reciprocal matrix WRT POPF

The following Fuzzy TFN matrix (5x5) is found from the opinion of both related professional and the user (5 professional, 5 users) by a Questionnaire. The best consistence matrix is used here

Table 4.9: (Expert 1) (pair-wise comparison matrix WRT POPF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.5, 2.0, 2.5	0.5, 0.67, 1.0	0.4,0.5,0.66	0.4, 0.5, 0.66
OPF	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.4, 0.5, 0.67
W	1.0, 1.5, 2.0	1.5, 2.0, 2.5	1,1,1	0.4, 0.5, 0.67	0.4,0.5,0.66
3G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1	0.67, 1.0, 2.0
4G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	0.5, 1.0, 1.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.1409,   C.I. = 0.0352246

So the consistency Ratio of this Matrix CR=CI/RI= 0.0352246/1.12= 0.0314 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Similarly other form matrices (WRT POPF)for Expert 2, 3, 4, are has been given in Appendix A

4.2.5 Establish a Fuzzy Positive reciprocal matrix WRT CRF

The following Fuzzy TFN matrix (5x5) is found from the opinion of both related professional and the user (5 professional, 5 users) by a Questionnaire. The best consistence matrix is used here

Table 4.10: (Expert 1) (pair-wise comparison matrix WRT CRF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.0, 1.5, 2.0	1.5, 2.0,, 2.5	0.5, 0.67, 1.0	0.5, 0.67, 1.0
OPF	0.5, 0.67, 1.0	1,1,1	2.0, 2.5, 3.0	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.33, 0.4, 0.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5
3G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1, 1, 1
4G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.32892,   C.I. = 0.0822294

So the consistency Ratio of this Matrix CR=CI/RI= 0.0822294/1.12= 0.0734 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Similarly other form matrices (WRT CRF) for Expert 2, 3, 4, are has been given in Appendix

4.2.6 Establish a Fuzzy Positive reciprocal matrix WRT RC

The following Fuzzy TFN matrix (5x5) is found from the opinion of both related professional and the user (5 professional, 5 users) by a Questionnaire. The best consistence matrix is used here

Table 4.11: (Expert 1) (pair-wise comparison matrix WRT RC)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33, 0.4	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5
OPF	2.5, 3.0, 3.5	1,1,1	2.0, 2.5, 3.0	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.33, 0.4, 0.5	1,1,1	1.0, 1.5, 2.0	1.0, 1.5, 2.0
3G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1, 1, 1
4G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.28913,   C.I. = 0.072283

So the consistency Ratio of this Matrix CR=CI/RI= 0.072283/1.12= 0.0645 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Similarly other form matrices (WRT RF) for Expert 2, 3, 4, are has been given in Appendix

4.2.7Aggregation of expert opinion of main attributes

Geometric mean operations are commonly used within the application of the AHP for aggregation group decisions (Davis, 1994, 52). We used the geometric means method to integrate the opinions of respondents in this research using Excel spread sheet .

$\tilde{A}_{11} = (\tilde{a}^{1}_{11} \otimes \tilde{a}^{2}_{11} \otimes \tilde{a}^{3}_{11} \otimes \ldots\ldots\ldots\ldots \otimes \tilde{a}^{5}_{11})^{1/5}$

$= ((1*1*1*1*1)^{1/5} , (1*1*1*1*1)^{1/5}, (1*1*1*1*1)^{1/5})$

$\tilde{A}_{11}= (1,1,1)$

Similarly, it can be calculated

$\tilde{A}_{12} = (2.0, 2.5, 3.0)$

$\tilde{A}_{13} = (1, 1, 1)$

$\tilde{A}_{14} = (1, 1, 1)$

$\tilde{A}_{15} = (1.5 ,2.0 ,2.5)$

$\tilde{A}_{16} = (0.5, 1.0, 1.5)$

$\tilde{A}_{17} = (0.38,0.45,0.61)$

$\tilde{A}_{21}, \tilde{a}_{22}, \tilde{a}_{23}, \tilde{a}_{24}, \tilde{a}_{25}, \ldots\ldots , \tilde{a}_{55}$.

So, the aggregated pair-wise comparison matrix for the main attributes is shown table

Table 4.12: Aggregated pair-wise comparison matrix of main attributes

	TF	EVF	EF	MF	POPF	CRF	RCF
TF	1,1,1	2.0,2.5,3.0	1, 1, 1	1, 1, 1	1.5,2.0,2.5	0.5,1.0,1.5	0.38,0.45,0.61
EVF	0.33,0.4,0.5	1,1,1	.38,.45,.61	1.0,1.5,2.0	0.5,0.66,1.0	1.5,2.0,2.5	1.5, 2.0, 2.5
EF	1,1,1	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	.38,.45,.61	1.5,2.0,2.5	1.5, 2.0, 2.5
MF	1,1,1	0.5,0.66,1.0	0.4,0.5,0.66	1,1,1	.38,.45,.61	1, 1, 1	0.4,0.5,0.67
POPF	0.4,0.5,0.67	1.0,1.5,2.0	1.5, 2.0, 2.5	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1, 1, 1
CRF	0.58,1.0,2.0	.38,.48,.60	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1,1,1	.38,.45,.61
RCF	1.5,2.0, 2.5	1.5, 2.0, 2.5	0.4,0.5,0.66	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1,1,1

4.2.8Aggregation of expert opinion of main factors WRT TF

Geometric mean operations are commonly used within the application of the AHP for aggregation group decisions (Davis, 1994, 52). We used the geometric means method to integrate the opinions of respondents in this research using Excel spread sheet .

$\tilde{A}_{11} =(\tilde{a}^1_{11} \otimes \tilde{a}^2_{11} \otimes \tilde{a}^3_{11} \otimes \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \otimes \tilde{a}^5_{11})^{1/5}$

$= ((1*1*1*1*1)^{1/5} , (1*1*1*1*1)^{1/5}, (1*1*1*1*1)^{1/5})$

$\tilde{A}_{11}= (1,1,1)$

Similarly , it can be calculated

$\tilde{A}_{12} = (0.33, 0.4, 0.5)$

$\tilde{A}_{13} = (0.29, 0.38, 0.48)$

$\tilde{A}_{14} = (0.33, 0.4, 0.5)$

$\tilde{A}_{15} = (0.28, 0.33, 0.4)$

$\tilde{A}_{21}$, $\tilde{a}_{22}$, $\tilde{a}_{23,}$ $\tilde{a}_{24\,,}$ $\tilde{a}_{25,}$ ………… , $\tilde{a}_{55}$.

So , the aggregated pair-wise comparison matrix of WRT TF is shown in table

Table:4.13 Pair-wise comparison matrix of WRT to TF

	COC	OPF	W	3G	4G
COC	1,1,1	0.33, 0.4, 0.5	0.29,0.38,0.48	0.33,0.4,0.5	0.28,0.33,0.4
OPF	2.0, 2.5, 3.0	1,1,1	2.0, 2.5, 0.5	0.33, 0.4, 0.5	2.0, 2.5, 3.0
W	2.0,2.5, 3.0	0.33,0.4, 0.5	1,1,1	0.66, 1.0, 2.0	0.66, 1.0, 2.0
3G	2.0, 2.5, 3.0	2.0, 2.5, 3.0	0.5, 1.0, 1.5	1,1,1	1,1,1
4G	2.5, 3.0, 3.5	0.33, 0.4, 0.5	0.5, 1.0, 1.5	1,1,1	1,1,1

4.2.9 Aggregation of expert opinion of main factors WRT EVF

Geometric mean operations are commonly used within the application of the AHP for aggregation group decisions (Davis, 1994, 52). We used the geometric means method to integrate the opinions of respondents in this research using Excel spread sheet .

$\tilde{A}_{11} = (\tilde{a}^1_{11} \otimes \tilde{a}^2_{11} \otimes \tilde{a}^3_{11} \otimes \ldots\ldots\ldots\ldots\ldots\ldots\ldots \otimes \tilde{a}^5_{11})^{1/5}$

$= ((1*1*1*1*1)^{1/5} , (1*1*1*1*1)^{1/5}, (1*1*1*1*1)^{1/5})$

$\tilde{A}_{11} = (1,1,1)$

Similarly , it can be calculated

$\tilde{A}_{12} = (1.5, 2.0, 2.5)$

$\tilde{A}_{13} = (0.38, 0.48, 0.59)$

$\tilde{A}_{14} = (1.0, 1.5, 2.0)$

$\tilde{A}_{15} = (1.0, 1.5, 2.0)$

$\tilde{A}_{21}$, $\tilde{a}_{22}$, $\tilde{a}_{23}$, $\tilde{a}_{24}$, $\tilde{a}_{25}$, ………… , $\tilde{a}_{55}$.

So , the aggregated pair-wise comparison matrix of WRT EVF is shown in table

Table:4.14 Pair-wise comparison matrix of WRT to EVF

	COC	OPF	W	3G	4G
COC	1,1,1	1.5, 2.0, 2.5	0.38,0.48,0.59	1.0, 1.5, 2.0	1.0, 1.5, 2.0
OPF	0.4, 0.5, 0.67	1,1,1	1.5, 2.0, 2.5	1.5,2.0, 2.5	1.5, 2.0, 2.5
W	1.0, 2.0, 2.5	0.38,0.48,0.61	1,1,1	0.5, 1.0, 1.5	0.5, 1.0, 1.5
3G	0.5, 0.66, 1.0	0.4, 0.5, 0.67	0.66, 1.0, 2.0	1,1,1	1, 1, 1
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	0.67, 1.0, 2.0	1,1,1	1,1,1

4.3.1 Aggregation of expert opinion of main factors WRT EF

Geometric mean operations are commonly used within the application of the AHP for aggregation group decisions (Davis, 1994, 52). We used the geometric means method to integrate the opinions of respondents in this research using Excel spread sheet .

$\tilde{A}_{11} = (\tilde{a}^1_{11} \otimes \tilde{a}^2_{11} \otimes \tilde{a}^3_{11} \otimes \ldots\ldots\ldots\ldots\ldots\ldots \otimes \tilde{a}^5_{11})^{1/5}$

$= ((1*1*1*1*1)^{1/5} , (1*1*1*1*1)^{1/5}, (1*1*1*1*1)^{1/5})$

$\tilde{A}_{11} = (1,1,1)$

Similarly , it can be calculated

$\tilde{A}_{12} = (0.28, 0.33, 0.4)$

$\tilde{A}_{13} = (0.38, 0.48, 0.61)$

$\tilde{A}_{14} = (0.4, 0.5, 0.67)$

$\tilde{A}_{15} = (0.4, 0.5, 0.67)$

$\tilde{A}_{21}$, $\tilde{a}_{22}$, $\tilde{a}_{23}$, $\tilde{a}_{24}$, $\tilde{a}_{25}$, ………… , $\tilde{a}_{55}$.

So , the aggregated pair-wise comparison matrix of WRT EF is shown in table

Table:4.15 Pair-wise comparison matrix of WRT to EF

	COC	OPF	W	3G	4G
COC	1,1,1	0.28,0.33,0.4	0.38,0.48,0.61	0.4, 0.5, 0.67	0.4, 0.5, 0.67
OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1,1,1	0.38,0.48,0.61	0.4, 0.5, 0.61
3G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1, 1, 1
4G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1,1,1

4.3.2 Aggregation of expert opinion of main factors WRT MF

Geometric mean operations are commonly used within the application of the AHP for aggregation group decisions (Davis, 1994, 52). We used the geometric means method to integrate the opinions of respondents in this research using Excel spread sheet .

$\tilde{A}_{11} = (\tilde{a}^{1}_{11} \otimes \tilde{a}^{2}_{11} \otimes \tilde{a}^{3}_{11} \otimes \ldots\ldots\ldots\ldots \otimes \tilde{a}^{5}_{11})^{1/5}$

$= ((1*1*1*1*1)^{1/5} , (1*1*1*1*1)^{1/5}, (1*1*1*1*1)^{1/5})$

$\tilde{A}_{11} = (1,1,1)$

Similarly , it can be calculated

$\tilde{A}_{12} = (0.28, 0.33, 0.4)$

$\tilde{A}_{13} = (1.5, 2.0, 2.5)$

$\tilde{A}_{14} = (1, 1.5, 2.0)$

$\tilde{A}_{15} = (1.0, 1.5, 2.0)$

$\tilde{A}_{21}$, $\tilde{a}_{22}$, $\tilde{a}_{23}$, $\tilde{a}_{24}$, $\tilde{a}_{25}$, ………… , $\tilde{a}_{55}$.

So , the aggregated pair-wise comparison matrix of WRT MF is shown in table

Table4.16: Pair-wise comparison matrix of WRT to MF

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33,0.4	1.5, 2.0, 2.5	1, 1.5, 2.0	1, 1.5, 2.0
OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	0.38,0.48,0.61	0.4, 0.5, 0.67
3G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	0.5, 0.67, 1.0
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1

4.3.3 Aggregation of expert opinion of main factors WRT POPF

Geometric mean operations are commonly used within the application of the AHP for aggregation group decisions (Davis, 1994, 52). We used the geometric means method to integrate the opinions of respondents in this research using Excel spread sheet .

$\tilde{A}_{11} = (\tilde{a}^{1}_{11} \otimes \tilde{a}^{2}_{11} \otimes \tilde{a}^{3}_{11} \otimes \ldots\ldots \otimes \tilde{a}^{5}_{11})^{1/5}$

$= ((1*1*1*1*1)^{1/5}, (1*1*1*1*1)^{1/5}, (1*1*1*1*1)^{1/5})$

$\tilde{A}_{11} = (1, 1, 1)$

Similarly, it can be calculated

$\tilde{A}_{12} = (1.5, 2.0, 2.5)$

$\tilde{A}_{13} = (0.5, 0.67, 1.0)$

$\tilde{A}_{14} = (0.38, 0.48, 0.61)$

$\tilde{A}_{15} = (0.4, 0.5, 0.66)$

$\tilde{A}_{21}$, $\tilde{a}_{22}$, $\tilde{a}_{23}$, $\tilde{a}_{24}$, $\tilde{a}_{25}$, ………… , $\tilde{a}_{55}$.

So, the aggregated pair-wise comparison matrix of WRT POPF is shown in table

Table:4.17 Pair-wise comparison matrix of WRT to POPF

	COC	OPF	W	3G	4G
COC	1,1,1	1.5, 2.0, 2.5	0.5, 0.67, 1.0	0.38,0.48,0.61	0.4, 0.5, 0.66
OPF	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.4, 0.5, 0.67
W	1.0, 1.5, 2.0	1.5, 2.0, 2.5	1,1,1	0.4, 0.5, 0.67	0.38,0.48,0.61
3G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1	0.67, 1.0, 2.0
4G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	0.5, 1.0, 1.5	1,1,1

4.3.4 Aggregation of expert opinion of main factors WRT CRF

Geometric mean operations are commonly used within the application of the AHP for aggregation group decisions (Davis, 1994, 52). We used the geometric means method to integrate the opinions of respondents in this research using Excel spread sheet .

$\tilde{A}_{11} = (\tilde{a}^{1}_{11} \otimes \tilde{a}^{2}_{11} \otimes \tilde{a}^{3}_{11} \otimes \ldots\ldots \otimes \tilde{a}^{5}_{11})^{1/5}$

$= ((1*1*1*1*1)^{1/5} , (1*1*1*1*1)^{1/5}, (1*1*1*1*1)^{1/5})$

$\tilde{A}_{11} = (1,1,1)$

Similarly , it can be calculated

$\tilde{A}_{12} = (1.0, 1.5, 2.0)$

$\tilde{A}_{13} = (1.5, 2.0, 2.5)$

$\tilde{A}_{14} = (0.5, 0.67, 1.0)$

$\tilde{A}_{15} = (0.5, 0.67, 1.0)$

$\tilde{A}_{21}$, $\tilde{a}_{22}$, $\tilde{a}_{23,}$ $\tilde{a}_{24\,,}$ $\tilde{a}_{25,}$ ………… , $\tilde{a}_{55}$.

So , the aggregated pair-wise comparison matrix of WRT CRF is shown in table

Table:4.18 Pair-wise comparison matrix of WRT to CRF

	COC	OPF	W	3G	4G
COC	1,1,1	1.0, 1.5, 2.0	1.5, 2.0,, 2.5	0.5, 0.67, 1.0	0.5, 0.67, 1.0
OPF	0.5, 0.67, 1.0	1,1,1	2.0, 2.5, 3.0	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.33, 0.4, 0.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5
3G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1, 1, 1
4G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1,1,1

4.3.5 Aggregation of expert opinion of main factors WRT RF

Geometric mean operations are commonly used within the application of the AHP for aggregation group decisions (Davis, 1994, 52). We used the geometric means method to integrate the opinions of respondents in this research using Excel spread sheet .

$\tilde{A}_{11} = (\tilde{a}^{1}_{11} \otimes \tilde{a}^{2}_{11} \otimes \tilde{a}^{3}_{11} \otimes \ldots\ldots\ldots\ldots \otimes \tilde{a}^{5}_{11})^{1/5}$

$= ((1*1*1*1*1)^{1/5} , (1*1*1*1*1)^{1/5}, (1*1*1*1*1)^{1/5})$

$\tilde{A}_{11} = (1,1,1)$

Similarly , it can be calculated

$\tilde{A}_{12} = (0.28, 0.33, 0.4)$

$\tilde{A}_{13} = (0.4, 0.5, 0.67)$

$\tilde{A}_{14} = (1.5, 2.0, 2.5)$

$\tilde{A}_{15} = (1.5, 2.0, 2.5)$

$\tilde{A}_{21}$, $\tilde{a}_{22}$, $\tilde{a}_{23,}$ $\tilde{a}_{24}$, $\tilde{a}_{25,}$ ………… , $\tilde{a}_{55}$.

So , the aggregated pair-wise comparison matrix of WRT RF is shown in table

Table:4.19 Pair-wise comparison matrix of WRT to RF

	COC	OPF	W	3G	4G
COC	1,1,1	0.28,0.33,0.4	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5
OPF	2.5, 3.0, 3.5	1,1,1	2.0, 2.5, 3.0	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.33, 0.4, 0.5	1,1,1	1.0, 1.5, 2.0	1.0, 1.5, 2.0
3G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1, 1, 1
4G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1,1,1

Chapter V

Computation of Rank

5.1 Calculation

5.1.1 Weight of main attribute

Now considering the middle value of pair-wise comparison matrix of the main attribute and calculated by AHP CGI Software.

Table 5.1 : Weights of main attribute

	TF	EVF	EF	MF	POPF	CRF	RCF	Value
TF	1	2.5	1	1	2	1	0.45	0.167715
EVF	0.4	1	0.45	1.5	0.66	2	2	0.13346
EF	1	2.22222	1	2	0.45	2	2	0.181407
MF	1	0.666667	0.5	1	0.45	1	0.5	0.088749
POPF	0.5	1.51515	2.22222	2.22222	1	2	1	0.181688
CRF	1	0.5	0.5	1	0.5	1	0.45	0.085999
RCF	2.22222	0.5	0.5	2	1	2.22222	1	0.160982

So the Weight of main attributes :

W= (TF, EVF, EF, MF, POPF, CRF, RCF)

= (0.167715, 0.13346, 0.181407, 0.088749, 0.181688, 0.085999, 0.160982)

5.1.2 Weights of WRT TF

Now considering the middle value of pair-wise comparison matrix WRT TF and calculated by AHP Software by CGI

Table 5.2: Weights WRT TF

	COC	OPF	W	3G	4G	Value
COC	1	0.4	0.38	0.4	0.33	0.079618
OPF	2.5	1	2.5	0.4	2.5	0.275513
W	2.63158	0.4	1	1	1	0.178049
3G	2.5	2.5	1	1	1	0.282911
4G	3.0303	0.4	1	1	1	0.283909

W = (COC, OPF, W, 3G, 4G)

= (0.079618, 0.275513, 0.178049, 0.282911, 0.283909)

5.1.3 Weights of WRT EVF

Now considering the middle value of pair-wise comparison matrix WRT EVF and calculated by AHP CGI Software.

Table 5.3 : Weights of factors WRT EVF

	COC	OPF	W	3G	4G		Value
COC	1	2	0.48	1.5	1.5		0.239987
OPF	0.5	1	2	2	2		0.256538
W	2.08333	0.5	1	1	1		0.209853
3G	0.666667	0.5	1	1	1		0.146811
4G	0.666667	0.5	1	1	1		0.146811

W=(COC,OPF,W,3G,4G) = (0.239987, 0.256538, 0.209853, 0.146811, 0.146811)

5.1.4 Weights of WRT EF

Now considering the middle value of pair-wise comparison matrix WRT EF and calculated by AHP CGI Software

Table 5.4: Weights WRT EF

	COC	OPF	W	3G	4G		Value
COC	1	0.33	0.48	0.5	0.5		0.095416
OPF	3.0303	1	2	2	2		0.34412
W	2.08333	0.5	1	0.48	0.5		0.140694
3G	2	0.5	2.08333	1	1		0.211035
4G	2	0.5	2	1	1		0.208735

W = (COC, OPF, W, 3G, 4G)

= (0.095416, 0.34412, 0.140694, 0.211035, 0.208735)

5.1.5 Weights WRT MF

Now considering the middle value of pair-wise comparison matrix WRT MF and calculated by .AHP CGI Software

Table 5.5 : Weights of factors WRT MF

	COC	OPF	W	3G	4G		Value
COC	1	0.33	2	1.5	1.5		0.199828
OPF	3.0303	1	2	2	2		0.35676
W	0.5	0.5	1	0.48	0.5		0.106099
3G	0.666667	0.5	2.08333	1	0.67		0.15632
4G	0.66667	0.5	2	1.49254	1		0.180993

W=(COC, OPF, W, 3G, 4G) = (0.199828, 0.35676, 0.106099, 0.15632, 0.180993)

5.1.6 Weights of WRT POPF

Now considering the middle value of pair-wise comparison matrix WRT POPF and calculated by AHP CGI Software

Table 5.6: Weights of factors WRT POPF

	COC	OPF	W	3G	4G		Value
COC	1	2	0.67	0.48	0.5		0.149296
OPF	0.5	1	0.5	0.5	0.5		0.108648
W	1.49254	2	1	0.5	0.48		0.175028
3G	2.08333	2	2	1	1		0.283303
4G	2	2	2.08333	1	1		0.283724

W = (COC, OPF, W , 3G, 4G) = (0.149296, 0.108648, 0.175028, 0.283303, 0.283724)

5.1.7 Weights of WRT CRF

Now considering the middle value of pair-wise comparison matrix WRT CRF and calculated by AHP CGI Software

Table 5.7: Weights of factors WRT CRF

	COC	OPF	W	3G	4G		Value
COC	1	1.5	2	0.67	0.67		0.220359
OPF	0.66667	1	2.5	2	2		0.275201
W	0.5	0.4	1	2	2		0.187908
3G	1.49254	0.5	0.5	1	1		0.158266
4G	1.49254	0.5	0.5	1	1		0.158266

W= (COC, OPF, W, 3G, 4G) = (0.220359, 0.275201, 0.187908, 0.158266, 0.158266)

5.1.8 Weights of WRT RC

Now considering the middle value of pair-wise comparison matrix WRT RC and calculated by AHP CGI Software

Table 5.8: Weights of factors WRT RC

	COC	OPF	W	3G	4G		Value
COC	1	0.33	0.5	2	2		0.173164
OPF	3.0303	1	2.5	2	2		0.366792
W	2	0.4	1	1.5	1.5		0.206802
3G	0.5	0.5	0.666667	1	1		0.126621
4G	0.5	0.5	0.66667	1	1		0.126621

W= (COC, OPF, W, 3G, 4G) = (0.173164, 0.366792, 0.206802, 0.126621, 0.126621)

5.1.9 Calculation of Global Weight

The summarization of individual attributes and their weight has been given in table

Table 5.9: Weights of Individual Attributes

Attribute	Value
TF	0.167715
EVF	0.13346
EF	0.181407
MF	0.088749
POPF	0.181688
CRF	0.085999
RC	0.160982

T he Average of individual Factor and their weights has been given in table

Table 5.10 : Average values of Individual Factors

Factors	Value
COC	0.164
OPF	0.283
W	0.172
3G	0.195
4G	0.198

5.2.1 Weight of each attributes and factors

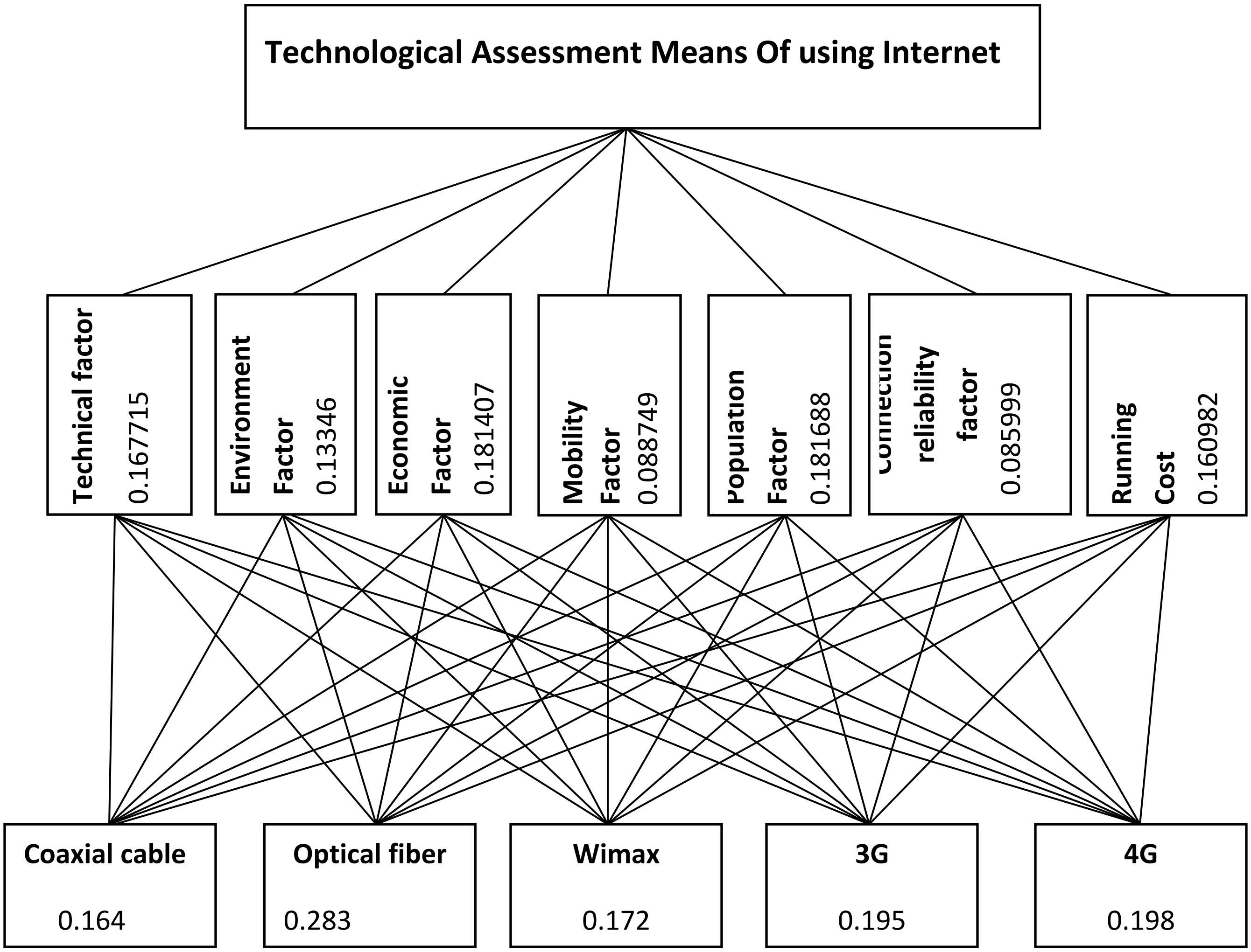


Fig 5.1 : Weight of each attributes and factors

For the priority ranking of Internet access media , calculation of global weight is necessary. The sample calculation of Global Weight is shown below :

For global weight of COC = Weight of [(TF*COC) + (EVF*COC) + (EF*COC) + (MF*COC) + (POPF*COC) + (CRF*COC) + (RC*COC)]

Similarly , for global weight of OPF, W , 3G and 4G

By using this formula and using Excel work sheet we can calculate the global weight of different Internet access media as shown in table and fig: 4

Table 5.11: Global Weight of different Internet access media

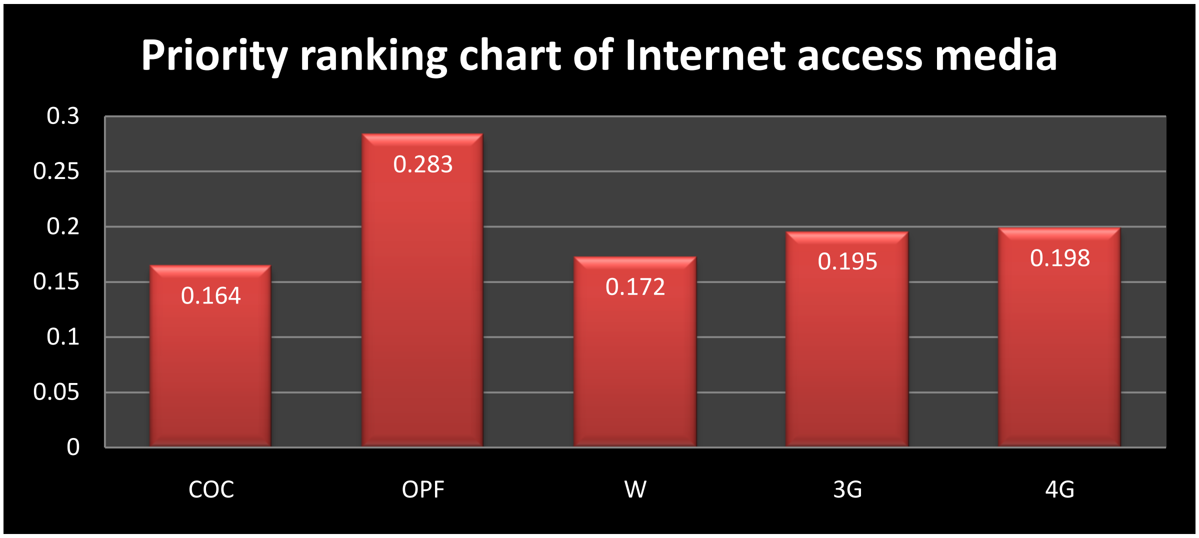
Factors	Global Weight
COC	0.164
OPF	0.283
W	0.172
3G	0.195
4G	0.198

5.2.2 Global weight and priority ranking table

For global weight and priority ranking of different Internet access media we use excel work sheet . As this is very simple Fuzzy AHP study, for that the average value weight is same as the global weight . so the ranking of customer satisfaction factors/attributes are as shown in table23:

Table 5.12: Ranking of Internet Access Media using Fuzzy-AHP taking experts opinions.

Internet Access Media	Rank (% of preference)
Coaxial Cable	5^{th} (16.4%)
Optical Fiber	1^{st} (28.3%)
Wimax	4^{th} (17.2%)
3G	3^{rd} (19.5%)
4G	2^{nd} (19.8%)



Chapter VI

Conclusion

6.1 Conclusion

In order to take full advantage of a Internet access media, selecting the best services is the first key step. Two approaches have been recently debated for this exercise. Ordoobadi [22] has pointed out that linguistics evaluations are difficult to translate into numeric scales because of their vagueness, imprecision and uncertainty. Therefore, he advocates the use of Fuzzy logic. Later, Labib [23] defends the view that AHP is superior because it allows consistency analysis, normalizing scores to sum to unity, and the ability to perform sensitivity analysis. In this thesis, we have shown that scores generated through Fuzzy Logic can also be normalized to one, and sensitivity analysis can also be performed. However, we have found another significant problem in Fuzzy logic: weight of a node depends on level of decomposition. AHP has some drawbacks as well. It lacks the possible benefits of handling vagueness in judgments during the conversion of verbal scales into a numeric scale. In this thesis, we first used Fuzzy AHP in order to capture the benefits of both methods. It offers a fuzzy conversion of the verbal scale into a numeric one and also offers a consistency analysis. As with the other two methods, it has the capability to perform sensitivity analysis which enables an understanding of the casual relationships between the criteria weights and the ranking of alternatives. The global scores can also be normalized to unity as in the others methods. In this study it is found that depending on our selected attributes (TF, EVF, EF, MF, POPF, CRF, RC) optical fiber should be the best option for accessing internet and 5th choice is coaxial cable. The 2nd, 3rd and 4th choices should be 4G, 3G and Wimax respectively.

6.2 Scope for further study

This study may be extended including more attributes, sub-attributes and the alternatives (Internet access media) to get more reliable and realistic result with rigorous mathematical calculation.

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APPENDIX A

Expert 2 (pair wise comparison matrix of main attributes)

	TF	EVF	EF	MF	POPF	CRF	RCF
TF	1,1,1	2.0,2.5,3.0	0.5,1.0,1.5	1, 1, 1	1.5,2.0,2.5	0.5,1.0,1.5	0.4,0.5,0.66
EVF	0.33,0.4,0.5	1,1,1	0.4,0.5,0.66	1.0,1.5,2.0	0.5,0.66,1.0	1.5,2.0,2.5	0.4,0.5,0.66
EF	0.66,1.0,2.0	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	0.4,0.5,0.66	1.5,2.0,2.5	1.5, 2.0, 2.5
MF	1,1,1	0.5,0.66,1.0	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1, 1, 1	0.4,0.5,0.67
POPF	0.4,0.5,0.67	1.0,1.5,2.0	1.5, 2.0, 2.5	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1, 1, 1
CRF	0.66,1.0,2.0	0.4,0.5,0.66	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66
RCF	1.5,2.0, 2.5	1.5, 2.0, 2.5	0.4,0.5,0.66	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 7.53149,   C.I. = 0.0885823

So the consistency Ratio of this Matrix CR=CI/RI= 0.0885823/1.32 = 0.0671 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 2 (pair wise comparison matrix of factors w.r.t TF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.33, 0.4, 0.5	0.33,0.4,0.5	0.4, 0.5, 0.66	0.28,0.33,0.4
OPF	2.0, 2.5, 3.0	1,1,1	2.0, 2.5, 3.0	0.33, 0.4, 0.5	2.0, 2.5, 3.0
W	2.0,2.5, 3.0	0.33,0.4, 0.5	1,1,1	0.5, 1.0,1.5	0.5,1.0,1.5
3G	1.5,2.0,2.5	2.0, 2.5, 3.0	1.0,1.0,1.0	1,1,1	1.0,1.0,1.0

4G	2.5, 3.0, 3.5	0.33, 0.4, 0.5	1.0,1.0,1.0	1.0,1.0,1.0	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 5.38143, C.I. = 0.0953579

So the consistency Ratio of this Matrix CR=CI/RI= 0.0953579/1.12 = 0.0851 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 2 (pairwise comparison matrix of factors w.r.t EVF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.0,1.5,2.0	0.4, 0.5, 0.66	1.0, 1.5, 2.0	1.0, 1.5, 2.0
OPF	0.5, 0.66,1.0	1,1,1	1.5, 2.0, 2.5	1.5,2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.4, 0.5, 0.66	1,1,1	0.5, 1.0, 1.5	0.5, 1.0, 1.5
3G	0.5, 0.66, 1.0	0.4, 0.5, 0.67	0.66, 1.0, 2.0	1,1,1	1, 1, 1
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	0.67, 1.0, 2.0	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 5.35019, C.I. = 0.0875483

So the consistency Ratio of this Matrix CR=CI/RI= 0.0875483/1.12 = 0.0781 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 2 (pair wise comparison matrix of factors w.r.t EF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33, 0.4	0.4,0.5,0.66	0.4, 0.5, 0.67	0.4, 0.5, 0.67
OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0,2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.66	0.4, 0.5, 0.61

3G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1, 1, 1
4G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 5.13674,   C.I. = 0.0341845

So the consistency Ratio of this Matrix CR=CI/RI= 0.0341845/1.12 = 0.03052 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 2 (Pair wise comparison matrix of factors w.r.t MF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.33,0.4,0.5	1.5, 2.0, 2.5	1, 1.5, 2.0	1, 1.5, 2.0
OPF	2.0,2.5,3.0	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	0.4, 0.5,0.66	0.4, 0.5, 0.67
3G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	0.5, 0.67, 1.0
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 5.34881,   C.I. = 0.0872017

So the consistency Ratio of this Matrix CR=CI/RI= 0.0872017/1.12 = 0.0778 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 2 (pair wise comparison matrix of factors w.r.t POPF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.5, 2.0, 2.5	0.5, 0.67, 1.0	0.4,0.5,0.66	0.4, 0.5, 0.66
OPF	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.4, 0.5, 0.67
W	1.0, 1.5, 2.0	1.5, 2.0, 2.5	1,1,1	0.5,0.66,1.0	0.4,0.5,0.66

3G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.0,1.5,2.0	1,1,1	0.67, 1.0, 2.0
4G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	0.5, 1.0, 1.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 5.11037,   C.I. = 0.0275928

So the consistency Ratio of this Matrix CR=CI/RI= 0.0275928/1.12 = 0.0246 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 2 (pair wise comparison matrix of factors w.r.t CRF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.0, 1.5, 2.0	1.5, 2.0,, 2.5	0.4,0.5,0.66	0.5, 0.67, 1.0
OPF	0.5, 0.67, 1.0	1,1,1	2.0, 2.5, 3.0	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.33, 0.4, 0.5	1,1,1	1.5, 2.0, 2.5	2.0,2.5,3.0
3G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1, 1, 1
4G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 5.4501,   C.I. = 0.112524

So the consistency Ratio of this Matrix CR=CI/RI= 0.112524/1.12 = 0.100 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 2 (pair wise comparison matrix of factors w.r.t RC)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33, 0.4	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5
OPF	2.5, 3.0, 3.5	1,1,1	2.0, 2.5, 3.0	1.5, 2.0, 2.5	1.5, 2.0, 2.5

W	1.5, 2.0, 2.5	0.33, 0.4, 0.5	1,1,1	1.0, 1.5, 2.0	1.0, 1.5, 2.0
3G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1, 1, 1
4G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.28913,   C.I. = 0.072283

So the consistency Ratio of this Matrix CR=CI/RI= 0.072283/1.12= 0.0645 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 3 (pair wise comparison matrix of main attributes)

	TF	EVF	EF	MF	POPF	CRF	RCF
TF	1,1,1	2.0,2.5,3.0	1, 1, 1	1, 1, 1	1.5,2.0,2.5	0.5,1.0,1.5	0.4,0.5,0.66
EVF	1,1,1	1,1,1	0.4,0.5,0.66	1.0,1.5,2.0	0.5,0.66,1.0	1.5,2.0,2.5	0.4,0.5,0.66
EF	1,1,1	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	0.4,0.5,0.66	1.5,2.0,2.5	1.5, 2.0, 2.5
MF	1,1,1	0.5,0.66,1.0	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1, 1, 1	0.4,0.5,0.67
POPF	0.4,0.5,0.67	1.0,1.5,2.0	1.5, 2.0, 2.5	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1, 1, 1
CRF	0.66,1.0,2.0	0.4,0.5,0.66	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66
RCF	1.5,2.0, 2.5	1.5, 2.0, 2.5	0.4,0.5,0.66	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 7.52669,   C.I. = 0.0877813

So the consistency Ratio of this Matrix CR=CI/RI= 0.0877813/1.32 = 0.066 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 3 (pair wise comparison matrix of factors w.r.t TF)

	COC	OPF	W	3G	4G

COC	1,1,1	0.33, 0.4, 0.5	0.33,0.4,0.5	0.33,0.4,0.5	0.28,0.33,0.4
OPF	2.0, 2.5, 3.0	1,1,1	2.0, 2.5, 3.0	0.33, 0.4, 0.5	2.0, 2.5, 3.0
W	2.0,2.5, 3.0	0.33,0.4, 0.5	1,1,1	0.66, 1.0, 2.0	0.66, 1.0, 2.0
3G	2.0, 2.5, 3.0	2.0, 2.5, 3.0	0.5, 1.0, 1.5	1,1,1	1.0, 1.0, 1.0
4G	2.5, 3.0, 3.5	0.33, 0.4, 0.5	0.5, 1.0, 1.5	1.0, 1.0, 1.0	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.34157,   C.I. = 0.0853922

So the consistency Ratio of this Matrix CR=CI/RI= 0.0853922/1.12= 0.0762 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 3 (pair wise comparison matrix of factors w.r.t EVF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.5,2.0, 2.5	0.4, 0.5, 0.66	1.0, 1.5, 2.0	1.0, 1.5, 2.0
OPF	0.4, 0.5, 0.67	1,1,1	1.5, 2.0, 2.5	1.5,2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.4, 0.5, 0.66	1,1,1	0.5, 1.0, 1.5	0.5, 1.0, 1.5
3G	0.5, 0.66, 1.0	0.4, 0.5, 0.67	0.66, 1.0, 2.0	1,1,1	1, 1, 1
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	0.67, 1.0, 2.0	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.44942,   C.I. = 0.112355

So the consistency Ratio of this Matrix CR=CI/RI= 0.112355/1.12= 0.1003 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 3 (pairwise comparison matrix of factors w.r.t EF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33, 0.4	0.4,0.5,0.66	0.4, 0.5, 0.67	0.4, 0.5, 0.67
OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.66	0.4, 0.5, 0.61
3G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1, 1, 1
4G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.13674, C.I. = 0.0341845

So the consistency Ratio of this Matrix CR=CI/RI= 0.0341845/1.12= 0.0305 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 3 (pair wise comparison matrix of factors w.r.t MF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33,0.4	1.5, 2.0, 2.5	1, 1.5, 2.0	1, 1.5, 2.0
OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	0.4, 0.5,0.66	0.4, 0.5, 0.67
3G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	0.5, 0.67, 1.0
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.27796, C.I. = 0.0694898

So the consistency Ratio of this Matrix CR=CI/RI= 0.0694898/1.12= 0.062< 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 3 (pair wise comparison matrix of factors w.r.t POPF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.5, 2.0, 2.5	0.5, 0.67, 1.0	0.4,0.5,0.66	0.4, 0.5, 0.66
OPF	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.4, 0.5, 0.67
W	1.0, 1.5, 2.0	1.5, 2.0, 2.5	1,1,1	0.4, 0.5, 0.67	0.4,0.5,0.66
3G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1	0.67, 1.0, 2.0
4G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	0.5, 1.0, 1.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.1409,   C.I. = 0.0352246

So the consistency Ratio of this Matrix CR=CI/RI= 0.0352246/1.12= 0.0314 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 3 (pair wise comparison matrix of factors w.r.t CRF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.0, 1.5, 2.0	1.5, 2.0,, 2.5	0.5, 0.67, 1.0	0.5, 0.67, 1.0
OPF	0.5, 0.67, 1.0	1,1,1	2.0, 2.5, 3.0	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.33, 0.4, 0.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5
3G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1, 1, 1
4G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.32892,   C.I. = 0.0822294

So the consistency Ratio of this Matrix CR=CI/RI= 0.0822294/1.12= 0.0734 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 3 (pair wise comparison matrix of factors w.r.t RC)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33, 0.4	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5
OPF	2.5, 3.0, 3.5	1,1,1	2.0, 2.5, 3.0	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.33, 0.4, 0.5	1,1,1	1.0, 1.5, 2.0	1.0, 1.5, 2.0
3G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1, 1, 1
4G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.28913,   C.I. = 0.072283

So the consistency Ratio of this Matrix CR=CI/RI= 0.072283/1.12= 0.0645 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 4 (pair wise comparison matrix of main attributes)

	TF	EVF	EF	MF	POPF	CRF	RCF
TF	1,1,1	2.0,2.5,3.0	0.5,1.0,1.5	1, 1, 1	1.5,2.0,2.5	0.5,1.0,1.5	0.4,0.5,0.66
EVF	0.33,0.4,0.5	1,1,1	0.4,0.5,0.66	1.0,1.5,2.0	0.5,0.66,1.0	1.5,2.0,2.5	0.4,0.5,0.66
EF	0.66,1.0,2.0	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	0.4,0.5,0.66	1.5,2.0,2.5	1.5, 2.0, 2.5
MF	1,1,1	0.5,0.66,1.0	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1, 1, 1	0.4,0.5,0.67
POPF	0.4,0.5,0.67	1.0,1.5,2.0	1.5, 2.0, 2.5	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1, 1, 1

CRF	0.66,1.0,2.0	0.4,0.5,0.66	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66
RCF	1.5,2.0, 2.5	1.5, 2.0, 2.5	0.4,0.5,0.66	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 7.53149, C.I. = 0.0885823

So the consistency Ratio of this Matrix CR=CI/RI= 0.0885823/1.32 = 0.0671 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 4 (pairwise comparison matrix of factors w.r.t TF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.33, 0.4, 0.5	0.4,0.5,0.66	0.33,0.4,0.5	0.28,0.33,0.4
OPF	2.0, 2.5, 3.0	1,1,1	2.0, 2.5, 3.0	0.33, 0.4, 0.5	2.0, 2.5, 3.0
W	2.0,2.5, 3.0	0.33,0.4, 0.5	1,1,1	1.0,1.0,1.0	1.0,1.0,1.0
3G	2.0, 2.5, 3.0	2.0, 2.5, 3.0	0.5, 1.0, 1.5	1,1,1	1.0,1.0,1.0
4G	2.5, 3.0, 3.5	0.33, 0.4, 0.5	0.5, 1.0, 1.5	1.0, 1.0, 1.0	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.38251, C.I. = 0.0956271

So the consistency Ratio of this Matrix CR=CI/RI= 0.0956271/1.12= 0.0854 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 4 (pair wise comparison matrix of factors w.r.t EVF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.5,2.0, 2.5	0.4, 0.5, 0.66	1.0, 1.5, 2.0	1.0, 1.5, 2.0
OPF	0.4, 0.5, 0.67	1,1,1	1.5, 2.0, 2.5	1.5,2.0, 2.5	1.0,1.5,2.0

W	1.5, 2.0, 2.5	0.4, 0.5, 0.66	1,1,1	0.5, 1.0, 1.5	0.5, 1.0, 1.5
3G	0.5, 0.66, 1.0	0.4, 0.5, 0.67	0.66,1.0,2.0	1,1,1	1.0,1.0,1.0
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	0.67, 1.0, 2.0	1.0,1.0,1.0	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.4185,   C.I. = 0.104625

So the consistency Ratio of this Matrix CR=CI/RI= 0.104625/1.12= 0.09341 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 4 (pair wise comparison matrix of factors w.r.t EF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33, 0.4	0.4,0.5,0.66	0.4, 0.5, 0.67	0.4, 0.5, 0.67
OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.66	0.33,0.4,0.5
3G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1.0,1.0,1.0
4G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.17077,   C.I. = 0.042693

So the consistency Ratio of this Matrix CR=CI/RI= 0.042693/1.12= 0.0381 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 4 (pair wise comparison matrix of factors w.r.t MF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33,0.4	1.5, 2.0, 2.5	1, 1.5, 2.0	1, 1.5, 2.0

OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	0.4, 0.5,0.66	0.4, 0.5, 0.67
3G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	0.5, 0.67, 1.0
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.27796,   C.I. = 0.0694898

So the consistency Ratio of this Matrix CR=CI/RI= 0.0694898/1.12= 0.06204< 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 4 (pair wise comparison matrix of factors w.r.t POPF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.5, 2.0, 2.5	0.5, 0.67, 1.0	0.4,0.5,0.66	0.4, 0.5, 0.66
OPF	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.67	0.5,0.66,1.0	0.4, 0.5, 0.67
W	1.0, 1.5, 2.0	1.5, 2.0, 2.5	1,1,1	0.4, 0.5, 0.67	0.4,0.5,0.66
3G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1	0.67, 1.0, 2.0
4G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	0.5, 1.0, 1.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.16404,   C.I. = 0.0410092

So the consistency Ratio of this Matrix CR=CI/RI= 0.0410092/1.12= 0.0366 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 4 (pair wise comparison matrix of factors w.r.t CRF)

	COC	OPF	W	3G	4G

COC	1,1,1	1.0, 1.5, 2.0	1.5, 2.0,, 2.5	0.5, 0.67, 1.0	0.5, 0.67, 1.0
OPF	0.5, 0.67, 1.0	1,1,1	2.0, 2.5, 3.0	2.0,2.5,3.0	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.33, 0.4, 0.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5
3G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1, 1, 1
4G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.34933, C.I. = 0.087333

So the consistency Ratio of this Matrix CR=CI/RI= 0.087333/1.12= 0.07797 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 4 (pair wise comparison matrix of factors w.r.t RC)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33, 0.4	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5
OPF	2.5, 3.0, 3.5	1,1,1	2.5,3.0,3.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.33, 0.4, 0.5	1,1,1	1.0, 1.5, 2.0	1.0, 1.5, 2.0
3G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1, 1, 1
4G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.312, C.I. = 0.0780011

So the consistency Ratio of this Matrix CR=CI/RI= 0.0780011/1.12= 0.0696 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 5 (pair wise comparison matrix of main attributes)

	TF	EVF	EF	MF	POPF	CRF	RCF
TF	1,1,1	2.0,2.5,3.0	1, 1, 1	1, 1, 1	1.5,2.0,2.5	0.5,1.0,1.5	0.4,0.5,0.66
EVF	1,1,1	1,1,1	0.4,0.5,0.66	1.0,1.5,2.0	0.5,0.66,1.0	1.5,2.0,2.5	0.4,0.5,0.66
EF	1,1,1	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	0.4,0.5,0.66	1.5,2.0,2.5	1.5, 2.0, 2.5
MF	1,1,1	0.5,0.66,1.0	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1, 1, 1	0.4,0.5,0.67
POPF	0.4,0.5,0.67	1.0,1.5,2.0	1.5, 2.0, 2.5	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1, 1, 1
CRF	0.66,1.0,2.0	0.4,0.5,0.66	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66	1,1,1	0.4,0.5,0.66
RCF	1.5,2.0, 2.5	1.5, 2.0, 2.5	0.4,0.5,0.66	1.5,2.0,2.5	1,1,1	1.5,2.0,2.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value = 7.52669, C.I. = 0.0877813

So the consistency Ratio of this Matrix CR=CI/RI= 0.0877813/1.32 = 0.066 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 5 (pair wise comparison matrix of factors w.r.t TF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.33, 0.4, 0.5	0.33,0.4,0.5	0.33,0.4,0.5	0.28,0.33,0.4
OPF	2.0, 2.5, 3.0	1,1,1	2.0, 2.5, 3.0	0.33, 0.4, 0.5	2.0, 2.5, 3.0
W	2.0,2.5, 3.0	0.33,0.4, 0.5	1,1,1	0.66, 1.0, 2.0	0.66, 1.0, 2.0
3G	2.0, 2.5, 3.0	2.0, 2.5, 3.0	0.5, 1.0, 1.5	1,1,1	1.0, 1.0, 1.0
4G	2.5, 3.0, 3.5	0.33, 0.4, 0.5	0.5, 1.0, 1.5	1.0, 1.0, 1.0	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.34157,   C.I. = 0.0853922

So the consistency Ratio of this Matrix CR=CI/RI= 0.0853922/1.12= 0.0762 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 5 (pair wise comparison matrix of factors w.r.t EVF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.5,2.0, 2.5	0.4, 0.5, 0.66	1.0, 1.5, 2.0	1.0, 1.5, 2.0
OPF	0.4, 0.5, 0.67	1,1,1	1.5, 2.0, 2.5	1.5,2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.4, 0.5, 0.66	1,1,1	0.5, 1.0, 1.5	0.5, 1.0, 1.5
3G	0.5, 0.66, 1.0	0.4, 0.5, 0.67	0.66, 1.0, 2.0	1,1,1	1, 1, 1
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	0.67, 1.0, 2.0	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.44942,   C.I. = 0.112355

So the consistency Ratio of this Matrix CR=CI/RI= 0.112355/1.12= 0.1003 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 5 (pair wise comparison matrix of factors w.r.t EF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33, 0.4	0.4,0.5,0.66	0.4, 0.5, 0.67	0.4, 0.5, 0.67
OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.66	0.4, 0.5, 0.61
3G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1, 1, 1
4G	1.5, 2.0, 2.5	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.13674,   C.I. = 0.0341845

So the consistency Ratio of this Matrix CR=CI/RI= 0.0341845/1.12= 0.0305 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 5 (pair wise comparison matrix of factors w.r.t MF)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33,0.4	1.5, 2.0, 2.5	1, 1.5, 2.0	1, 1.5, 2.0
OPF	2.5, 3.0, 3.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	0.4, 0.5,0.66	0.4, 0.5, 0.67
3G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1,1,1	0.5, 0.67, 1.0
4G	0.5, 0.67, 1.0	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.27796,   C.I. = 0.0694898

So the consistency Ratio of this Matrix CR=CI/RI= 0.0694898/1.12= 0.062< 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 5 (pair wise comparison matrix w.r.t POPF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.5, 2.0, 2.5	0.5, 0.67, 1.0	0.4,0.5,0.66	0.4, 0.5, 0.66
OPF	0.4, 0.5, 0.67	1,1,1	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.4, 0.5, 0.67
W	1.0, 1.5, 2.0	1.5, 2.0, 2.5	1,1,1	0.4, 0.5, 0.67	0.4,0.5,0.66

3G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1,1,1	0.67, 1.0, 2.0
4G	1.5, 2.0, 2.5	1.5, 2.0, 2.5	1.5, 2.0, 2.5	0.5, 1.0, 1.5	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.1409, C.I. = 0.0352246

So the consistency Ratio of this Matrix CR=CI/RI= 0.0352246/1.12= 0.0314 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 5 (pair wise comparison matrix of factors w.r.t CRF)

	COC	OPF	W	3G	4G
COC	1,1,1	1.0, 1.5, 2.0	1.5, 2.0,, 2.5	0.5, 0.67, 1.0	0.5, 0.67, 1.0
OPF	0.5, 0.67, 1.0	1,1,1	2.0, 2.5, 3.0	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	0.4, 0.5, 0.67	0.33, 0.4, 0.5	1,1,1	1.5, 2.0, 2.5	1.5, 2.0, 2.5
3G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1, 1, 1
4G	1.0, 1.5, 2.0	0.4, 0.5, 0.67	0.4, 0.5, 0.67	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.32892, C.I. = 0.0822294

So the consistency Ratio of this Matrix CR=CI/RI= 0.0822294/1.12= 0.0734 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Expert 5 (pair wise comparison matrix w.r.t RC)

	COC	OPF	W	3G	4G
COC	1,1,1	0.28, 0.33, 0.4	0.4, 0.5, 0.67	1.5, 2.0, 2.5	1.5, 2.0, 2.5

OPF	2.5, 3.0, 3.5	1,1,1	2.0, 2.5, 3.0	1.5, 2.0, 2.5	1.5, 2.0, 2.5
W	1.5, 2.0, 2.5	0.33, 0.4, 0.5	1,1,1	1.0, 1.5, 2.0	1.0, 1.5, 2.0
3G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1, 1, 1
4G	0.4, 0.5, 0.67	0.4, 0.5, 0.67	0.5, 0.67, 1.0	1,1,1	1,1,1

C.I. of this matrix (calculated by CGI AHP Software)

Maximum Eigen Value =5.28913,   C.I. = 0.072283

So the consistency Ratio of this Matrix CR=CI/RI= 0.072283/1.12= 0.0645 < 0.10, that is this pair-wise comparison matrix has a very good Consistency.

Construct Questioners

Goal to provide internet connection with minimum cost. Reliable connection environment friendly.

A. To ensure minimum cost reliable and environment friendly internet connection in Bangladesh perspective.
   1. How important / preferable is Technical Factor (TF) when it is compared with Environment Factor?
   2. How important / preferable is Technical Factor (TF) when it is compared with Economic Factor?
   3. How important / preferable is Technical Factor (TF) when it is compared with Mobility Factor?
   4. How important / preferable is Technical Factor (TF) when it is compared with Population Factor?
   5. How important / preferable is Technical Factor (TF) when it is compared with Connection reliability Factor?
   6. How important / preferable is Technical Factor (TF) when it is compared with Running cost Factor?
   7. How important / preferable is Environment Factor (EVF) when it is compared with Economic Factor?
   8. How important / preferable is Environment Factor (EVF) when it is compared with Mobility Factor?
   9. How important / preferable is Environment Factor (EVF) when it is compared with Population Factor?

10. How important / preferable is Environment Factor (EVF) when it is compared with Connection reliability Factor?
11. How important / preferable is Environment Factor (EVF) when it is compared with Running Cost Factor?
12. How important / preferable is Economic Factor (EF) when it is compared with Mobility Factor?
13. How important / preferable is Economic Factor (EF) when it is compared with Population Factor?
14. How important / preferable is Economic Factor (EF) when it is compared with Connection reliability Factor?
15. How important / preferable is Economic Factor (EF) when it is compared with Running Cost Factor?
16. How important / preferable is Mobility Factor (MF) when it is compared with Population Factor?
17. How important / preferable is Mobility Factor (MF) when it is compared with Connection reliability Factor?
18. How important / preferable is Mobility Factor (MF) when it is compared with Running cost Factor?
19. How important / preferable is Population Factor (POF) when it is compared with Connection reliability Factor?
20. How important / preferable is Population Factor (POF) when it is compared with Running cost Factor?
21. How important / preferable is Connection reliability Factor (CRF) when it is compared with Running cost Factor?

With respect to over goal		Importance of one main attribute over another											
		Attribute of LHS is					MIDDLE	Attribute of RHS is					
Question	Attribute	Absolute more important	Very strong important	Strongly more important	Weakly more important	Equal more important	Just Equal	Equal more important	Weakly more important	Strongly more important	Very strong important	Absolute more important	Attribute
Than attribute of RHS								Than attribute of LHS					
1	TA												EF
2	TA												RF

3	TA												POPF
4	TA												ECOF
5	EF												POPF
6	EF												ECOF
7	EF												RF
8	ECOF												RF
9	ECOF												POPF
10	RF												POPF

B. With respect to Main Attribute “Technical Factor”.

1. How important / preferable is Coaxial Cable(COC) when it is compared with Optical Fiber(OPF)?
2. How important / preferable is Coaxial Cable(COC) when it is compared with Wimax(W)?
3. How important / preferable is Coaxial Cable(COC) when it is compared with 3G?
4. How important / preferable is Coaxial Cable(COC) when it is compared with 4G?
5. How important / preferable is Optical Fiber(OPF) when it is compared with Wimax(W)?
6. How important / preferable is Optical Fiber(OPF) when it is compared with 3G?
7. How important/preferable is Optical Fiber(OPF) when it is compared with 4G?
8. How important/preferable is Wimax(W) when it is compared with 3G?
9. How important/preferable is Wimax(W) when it is compared with 4G?
10. How important/preferable is 3G when it is compared with 4G?

With respect to Radiation hazard		Importance of one main attribute over another											
		Attribute of LHS is					MIDDLE	Attribute of RHS is					
Question	Attribute	Absolute more	Very strong important	Strongly more important	Weakly more important	Equal more important	Just Equal	Equal more important	Weakly more important	Strongly more important	Very strong important	Absolute more	Attribute
Than attribute of RHS							Than attribute of LHS						
1	COC												OPF

2	COC												W
3	COC												3G
4	COC												4G
5	OPF												W
6	OPF												3G
7	OPF												4G
8	W												3G
9	W												4G
10	3G												4G

C. With respect to Main Attribute “Environment Factor”

1. How important / preferable is Coaxial Cable(COC) when it is compared with Optical Fiber(OPF)?
2. How important / preferable is Coaxial Cable(COC) when it is compared with Wimax(W)?
3. How important / preferable is Coaxial Cable(COC) when it is compared with 3G?
4. How important / preferable is Coaxial Cable(COC) when it is compared with 4G?
5. How important / preferable is Optical Fiber(OPF) when it is compared with Wimax(W)?
6. How important / preferable is Optical Fiber(OPF) when it is compared with 3G?
7. How important/preferable is Optical Fiber(OPF) when it is compared with 4G?
8. How important/preferable is Wimax(W) when it is compared with 3G?
9. How important/preferable is Wimax(W) when it is compared with 4G?
10. How important/preferable is 3G when it is compared with 4G?

<table>
<tr><td rowspan="2">With respect to Radiation hazard</td><td colspan="3">Importance of one main attribute over another</td></tr>
<tr><td>Attribute of LHS is</td><td>MIDDLE</td><td>Attribute of RHS is</td></tr>
</table>

Question	Attribute	Absolute more	Very strong important	Strongly more important	Weakly more important	Equal more important	Just Equal	Equal more important	Weakly more important	Strongly more important	Very strong important	Absolute more	Attribute
Than attribute of RHS								Than attribute of LHS					
1	COC												OPF
2	COC												W
3	COC												3G
4	COC												4G
5	OPF												W
6	OPF												3G
7	OPF												4G
8	W												3G
9	W												4G
10	3G												4G

D. With respect to Main Attribute “Economic Factor”.

1. How important / preferable is Coaxial Cable(COC) when it is compared with Optical Fiber(OPF)?
2. How important / preferable is Coaxial Cable(COC) when it is compared with Wimax(W)?
3. How important / preferable is Coaxial Cable(COC) when it is compared with 3G?
4. How important / preferable is Coaxial Cable(COC) when it is compared with 4G?
5. How important / preferable is Optical Fiber(OPF) when it is compared with Wimax(W)?
6. How important / preferable is Optical Fiber(OPF) when it is compared with 3G?
7. How important/preferable is Optical Fiber(OPF) when it is compared with 4G?
8. How important/preferable is Wimax(W) when it is compared with 3G?
9. How important/preferable is Wimax(W) when it is compared with 4G?
10. How important/preferable is 3G when it is compared with 4G?

With respect to Radiation hazard on plants and animals		Importance of one main attribute over another											
		Attribute of LHS is					MIDDLE	Attribute of RHS is					
Question	Attribute	Absolute more important	Very strong important	Strongly more important	Weakly more important	Equal more important	Just Equal	Equal more important	Weakly more important	Strongly more important	Very strong important	Absolute more important	Attribute
Than attribute of RHS							Than attribute of LHS						
1	COC												OPF
2	COC												W
3	COC												3G
4	COC												4G
5	OPF												W
6	OPF												3G
7	OPF												4G
8	W												3G
9	W												4G
10	3G												4G

E. With respect to Main Attribute "Mobility Factor"

1. How important / preferable is Coaxial Cable(COC) when it is compared with Optical Fiber(OPF)?
2. How important / preferable is Coaxial Cable(COC) when it is compared with Wimax(W)?
3. How important / preferable is Coaxial Cable(COC) when it is compared with 3G?
4. How important / preferable is Coaxial Cable(COC) when it is compared with 4G?
5. How important / preferable is Optical Fiber(OPF) when it is compared with Wimax(W)?
6. How important / preferable is Optical Fiber(OPF) when it is compared with 3G?
7. How important/preferable is Optical Fiber(OPF) when it is compared with 4G?
8. How important/preferable is Wimax(W) when it is compared with 3G?

9. How important/preferable is Wimax(W) when it is compared with 4G?
10. How important/preferable is 3G when it is compared with 4G?

With respect to Running cost		Importance of one main attribute over another											
		Attribute of LHS is					MIDDLE	Attribute of RHS is					
Question	Attribute	Absolute more important	Very strong important	Strongly more important	Weakly more important	Equal more important	Just Equal	Equal more important	Weakly more important	Strongly more important	Very strong important	Absolute more important	Attribute
Than attribute of RHS							Than attribute of LHS						
1	COC												OPF
2	COC												W
3	COC												3G
4	COC												4G
5	OPF												W
6	OPF												3G
7	OPF												4G
8	W												3G
9	W												4G
10	3G												4G

F. With respect to Main Attribute “Population Factor”

1. How important / preferable is Coaxial Cable(COC) when it is compared with Optical Fiber(OPF)?
2. How important / preferable is Coaxial Cable(COC) when it is compared with Wimax(W)?
3. How important / preferable is Coaxial Cable(COC) when it is compared with 3G?
4. How important / preferable is Coaxial Cable(COC) when it is compared with 4G?
5. How important / preferable is Optical Fiber(OPF) when it is compared with Wimax(W)?

6. How important / preferable is Optical Fiber(OPF) when it is compared with 3G?
7. How important/preferable is Optical Fiber(OPF) when it is compared with 4G?
8. How important/preferable is Wimax(W) when it is compared with 3G?
9. How important/preferable is Wimax(W) when it is compared with 4G?
10. How important/preferable is 3G when it is compared with 4G?

With respect to Fixed cost		Importance of one main attribute over another											
		Attribute of LHS is					MIDDLE	Attribute of RHS is					
Question	Attribute	Absolute more important	Very strong important	Strongly more important	Weakly more important	Equal more important	Just Equal	Equal more important	Weakly more important	Strongly more important	Very strong important	Absolute more important	Attribute
Than attribute of RHS							Than attribute of LHS						
1	COC												OPF
2	COC												W
3	COC												3G
4	COC												4G
5	OPF												W
6	OPF												3G
7	OPF												4G
8	W												3G
9	W												4G
10	3G												4G

G. With respect to Main Attribute “Connection reliability Factor”

1. How important / preferable is Coaxial Cable(COC) when it is compared with Optical Fiber(OPF)?

2. How important / preferable is Coaxial Cable(COC) when it is compared with Wimax(W)?
3. How important / preferable is Coaxial Cable(COC) when it is compared with 3G?
4. How important / preferable is Coaxial Cable(COC) when it is compared with 4G?
5. How important / preferable is Optical Fiber(OPF) when it is compared with Wimax(W)?
6. How important / preferable is Optical Fiber(OPF) when it is compared with 3G?
7. How important/preferable is Optical Fiber(OPF) when it is compared with 4G?
8. How important/preferable is Wimax(W) when it is compared with 3G?
9. How important/preferable is Wimax(W) when it is compared with 4G?
10. How important/preferable is 3G when it is compared with 4G?

With respect to Availability of raw input Resource		Importance of one main attribute over another											
		Attribute of LHS is					MIDDLE	Attribute of RHS is					
Question	Attribute	Absolute more important	Very strong important	Strongly more important	Weakly more important	Equal more important	Just Equal	Equal more important	Weakly more important	Strongly more important	Very strong important	Absolute more important	Attribute
Than attribute of RHS							Than attribute of LHS						
1	COC												OPF
2	COC												W
3	COC												3G
4	COC												4G
5	OPF												W
6	OPF												3G
7	OPF												4G
8	W												3G
9	W												4G
10	3G												4G

H. With respect to Main Attribute “Running Cost”

1. How important / preferable is Coaxial Cable(COC) when it is compared with Optical Fiber(OPF)?
2. How important / preferable is Coaxial Cable(COC) when it is compared with Wimax(W)?
3. How important / preferable is Coaxial Cable(COC) when it is compared with 3G?
4. How important / preferable is Coaxial Cable(COC) when it is compared with 4G?
5. How important / preferable is Optical Fiber(OPF) when it is compared with Wimax(W)?
6. How important / preferable is Optical Fiber(OPF) when it is compared with 3G?
7. How important/preferable is Optical Fiber(OPF) when it is compared with 4G?
8. How important/preferable is Wimax(W) when it is compared with 3G?
9. How important/preferable is Wimax(W) when it is compared with 4G?
10. How important/preferable is 3G when it is compared with 4G?

With respect to Availability of skilled man power		Importance of one main attribute over another											
		Attribute of LHS is					MIDDLE	Attribute of RHS is					
Question	Attribute	Absolute more important	Very strong important	Strongly more important	Weakly more important	Equal more important	Just Equal	Equal more important	Weakly more important	Strongly more important	Very strong important	Absolute more important	Attribute
Than attribute of RHS								Than attribute of LHS					
1	COC												OPF
2	COC												W
3	COC												3G
4	COC												4G
5	OPF												W
6	OPF												3G
7	OPF												4G
8	W												3G
9	W												4G

10	3G												4G