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MASTER'S THESIS

Identification of Quality Parameters of B2C Commercial Websites in Iran Using Fuzzy Set Method

- Case Study: e-book shop

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MASTER'S THESIS

Identification of Quality Parameters of B2C Commercial Websites in Iran Using Fuzzy Set Method (Case Study: e-book shop)

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Abstract

In this thesis, the meaning of website quality and the parameters that affect on it were surveyed entirely. The most important factors of website quality that may cause a website to be more useful and also to become more successful were found.

In this research first of all, in literature review that is in chapter two, the meaning of market, electronic market, Business to customer (B2C) form of the electronic commerce and also more recently specific website issues are going to be mentioned. At the half-end of chapter two, website quality as one of the most important and effective factors of website specific issued was illustrated completely.

In the chapter three the research methodology of this thesis was designed that is how to rank all the affected parameters on website quality by help of technique for order preference by similarity to ideal solution (TOPSIS) and then to compare all the result of it by fuzzy TOPSIS with using fuzzy trapezoid numbers. Then it will shows how to interview with expert just in order to make the pairwise matrix so that it will give all the ranking factors weight through using analytical hieratical process (AHP), using fuzzy trapezoid numbers too. Finally, eight of the most important factors of website quality was ranked through the fuzzy TOPSIS and then were weighted through the AHP fuzzy.

In chapter four, data gathering and analyzing the data that included the description of TOPSIS, fuzzy TOPSIS, and fuzzy AHP methods with trapezoid numbers and also the calculation tables was demonstrated completely. At the end in the chapter five, there is a conclusion part of thesis and the references in follows.

Keywords: Website quality, information quality, system quality, service quality, vendor specific quality

Acknowledgment

I am extremely grateful to God for without His mercy and comfort this thesis would not have been accomplished.

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Chapter 1
Introduction

1.1. Introduction

Many companies investigate lots of money on their commercial websites. It is essential for companies to know more about their websites for example how many visitors they have or how often do they buy and etc. Lots of companies lose great deal of budget just because they don't know how their website should be qualified. Today with this huge amount of competitors, all companies should have qualified websites because it is somehow essential to know that companies who use their websites for transaction, *website quality may have a major impact on number of visitors* [Auger, 2005]. Therefore, it is obviously important to find out the dimensions of website quality and major factors which influence it, just to reserve a higher position for yourself in e-commerce.

1.2. Backgrounds

A company's or a website's continued success comes from two groups: new customers and repeat customers. Since it always costs more to attract new customers than to retain current customers, customer retention is more critical than customer attraction. The key to customer retention is customer satisfaction. Delighting customers goes beyond satisfying customers. Delighted customers are more effective advertisers than all the paid advertisements placed in the media [Kotler, 2006].

1.2.1. Market

Almost every one in the world has an experience with market, we do our businesses, may buy or sell something in the market, therefore markets join to our lives closely, and it means that every one knows it well but just few people in the world may know market mechanism which is important to understand its function better.

In this chapter market, its component, and its functions will be introduced.

1.2.2. Market Definition

There are lots of definitions about market in books which already all of them are correct but with the different words. Some of them emphasize on some characteristic and the some of them emphasize on the other parts of the market components, in the below definitions important parts of its role described:

A place for potential exchanges is a market. The size of a market changes with a price. The size of a market depends on the people who 1st like the product 2nd ready to exchange the essential resources to gain the product. [Roosta, 2001]

Markets play a central role in the economy, facilitating the exchange of information, goods, services, and payments. In the process, they create economic value for buyer, seller, market intermediaries, and for society at large. Recent years have seen a dramatic increase in the role of information technology in markets, both in traditional markets, and in the emergence of electronic marketplaces, such as the multitude of Internet-based online auctions. [Bakos, 1998]

A classical marketplace is a historically-evolved institution where customer and supplier meet each other at a certain place and a certain time in order to announce buying and selling intentions, which eventually match and may be settled, and where the activity is governed by price and competition. [B.Increasing, 1996]

A market place, from the traditional point of view, is a site where buyers and sellers gather and interact in order to trade commodities. Market places are characterized by the products, product-related concepts, regulations, protocols, and standardized means of transaction. [Marcel, 2004]

As we searched in lots of definition they tried to say that market is a place where buyer & seller exchange goods / product/service with competitive price through a mechanism which this may be different in each market.

Market components are the same but market characteristics may be differ in each market depending on what kind of market it is.

1.2.3. Market Components

When these items are available, market will appears, so market components are: [Roosta, 2001]

1. Buyer: a person who is ready to pay money to obtain a product or receive a service
2. Seller: a person who take money and give a related product to buyer
3. Price: amount of money/cost that should pay for a product to have it
4. Place: location where buyer and seller meet each other
5. Goods, products & service: an item that satisfies a market's want or need
6. Law for exchanges: rules to do merchandising better
7. Mechanism: exchange in markets happens through a systematic way or device

1.2.4. Functions of a Market

Markets have three main functions, summarized in table 1: matching buyers & sellers, facilitating the exchange of information, goods, services & payments associated with market transactions; and providing an intuitional infrastructure is typically the province of governments. Internet-based electronic market places leverage information technology to perform these functions with increased effectiveness and reduced transaction cost, resulting in more efficient "friction-free" markets.

Matching Buyers & Sellers, markets "clear" by matching demand & supply. This process of matching buyers demand with seller's product offerings has three main components: determining, product offering, search, and price discovery. The behavior of buyers, sellers and intermediaries is motivated by their desire to maximize their private utility. When markets function well, this also leads to an efficient allocation of productive resources. Viewed this way, markets are the engine and steering system of our economy.

Markets provide sellers with information about demand that allows them to employ economic inputs such as capital, technology and labor, and develop products with characteristic that match the needs of buyer, sellers determine a schedule of product offering that they expect will maximize their profits based on: [Bakos, 1998]

- Information about buyer demand
- The cost of inputs
- The available technology for production and distribution of the information, goods, and services purchased by the buyers; and
- The transaction costs of administering production, distribution, and payment.

Buyers select their purchases from the available product offerings after considering factors such as price and product characteristic. In obtaining and processing this information, buyer face

search cost. These costs include the opportunity cost of time spent searching , as well as associated expenditures such as driving, telephone calls, computer fees, magazine sub-scriptions, etc. typically, sellers exploit these search costs by raising their prices, and thus enjoy higher profits. Similarly sellers may face search costs in locating qualified buyers for their products, such as market research, advertising and sales calls.

A key function of markets in our economic system is price discovery, which is the process of determining the prices at which demand and supply "clear" and trade occurs. For certain markets, such as financial markets, this is their primary function. Markets can employ a number of mechanisms for price discovery.

For instance, some financial markets use one or more of the several types of auctions to determine prices, such as the "call market" auction at the opening of a trading day at the New York Stock Exchange, when bids are accepted up to a certain time and exchange occurs when the market opens. This is the first price that is communicated via the stock market ticker to the market at large, kicking off a day of "continuous market" trading. Other markets, such as the traditional automobile dealership, employ negotiation between buyers and sellers until a price is reached. In still other markets, such as the typical department store, merchants make firm offers that customers can either take or leave. [Bakos, 1998]

Facilitation of Transactions. The matching function of a market establishes at bilateral relationship between a buyer and seller. After a transaction is agreed upon, the product sold must be transported to the buyer (logistics), and payment must be transferred to the seller (settlement). Markets typically incorporate mechanisms for logistics and settlement: when a travel agent uses an airline reservations system to book a flight, the system will generate the itinerary and the ticket, and will process a credit card payment. Furthermore, market transactions require the establishment of a certain level of trust, which protects buyers, sellers and intermediaries from the opportunistic behavior of other market participants. For instance, this trust role may include banks issuing letters of credit, credit reporting bureaus, or rating agencies such as *consumer reports* and better business bureaus, which keep track of product information and seller reputations, and thus discourage opportunistic behavior. Finally, markets provide the physical infrastructure that allows transactions between the buyers and the sellers to take place. This includes real assets such a physical structures and trading floors, computers and communication networks, and transportation systems. [Bakos, 1998]

Institutional Infrastructure. The institutional infrastructure specifies the laws, rules and regulations that govern market transaction, such as issues related to contract law, dispute resolution, and intellectual property protection, and provides mechanism for their enforcement. In

addition, the dynamics of electronic markets may raise certain antitrust issues. For example there are large economies of scale in distribution, as a single online retailer or intermediary can serve a very large market. There are also potential demand-side economies of scale in payment mechanisms and software. These may lead to a winner-take-all market structure with one or a few firms dominating the market. [Bakos, 1998]

Table 1.1 Markets functions [Bakos, 1998]

Function	Indices
1. **Matching buyer & seller**	
	1.1. Determination of Product offering
	Product features offer ed by seller
	Aggregation of different products
	1.*2.* Search (of buyer for sellers & sellers for buyers)
	Price & product information
	Matching seller offerings with buyer preference
	1.3. Price discovery
	Process & outcomes in determination of prices
2. **Facilitation of transactions**	
	2.1. Logistics
	Delivery of information ,goods & service to buyer
	2.2. Settlement
	Transfer of payment to seller
	2.3. Trust
	Credit system, reputation, rating agencies like consumer reports & better business brochures
3. **Institutional infrastructure**	
	3.1. Legal
	Commercial code, contract law, dispute resolution, intellectual property protection
	3.2. Regulatory
	Rules & regulations, monitoring ,enforcement

1.2.5. Electronic Market

Electronic markets represent the next step in the evolution of the former market places. In the last chapter, we introduce physical market definitions; in this chapter the purpose is to find everything completely about electronic marketplace. In order to define and understand this new concept of "electronic market" and to point out the major differences between physical and virtual markets, we will start with EMP definitions, besides it continues with its function and roles at the end.

1.2.6. Electronic Market Definitions

An electronic marketplace or exchange is an online market (online markets are commerce sites on the public Internet that allow large communities of buyers and suppliers to "meet" and trade with each other. They present ideal structures for commercial exchange, achieving new levels of market efficiency by tightening and automating the relationship between supplier and buyer) where buyers and sellers use the Internet as a communication platform in order to exchange information, goods and services.

An online market, usually B2B (E-commerce model in which all of the participants are businesses or other organizations), in which buyers and sellers exchange goods or services.

The three types of E-marketplaces are private, public, and consortia [Turban 2006].

Public E-Marketplaces

Public e-marketplace are B2B markets. They often owned by a third party (not a seller or a buyer) or by a group of buying or selling companies (a consortium), and they serve many sellers and many buyers. These markets also are known as exchanges. They are open to the public and are regulated by the government or the exchange's owner.

Private E-Marketplaces

Private e-marketplace are those owned by a single company .private markets are either sell-side or buy-side.

i. Private E-marketplace: Online markets owned by a single company; maybe either sell side or buy side e-marketplace.
ii. Public E-marketplace: B2B marketplaces, usually owned and/or managed by an independent third party, that include many sellers and many buyers; also known as exchanges.
iii. Consortia: An exchange formed and operated by a group of major companies to provide industry wide transaction services.

The appeal of doing business on the web is clear. By bringing together huge numbers of buyers and sellers and by automating transactions, Electronic markets expand the choices available to buyers, give sellers access to new customers, and reduce transaction costs for all the players. By extracting fees for the transactions occurring within the B2B market places, market makers can earn vast revenues [Kaplan 2000]. One of the most significant problems of physical markets is the information deficiency or asymmetry between the market participants. In the last decade a new market form emerged: The electronic or virtual market. Electronic markets are made possible by merging telecommunication and informatics and attempt to overcome the asymmetry problem.

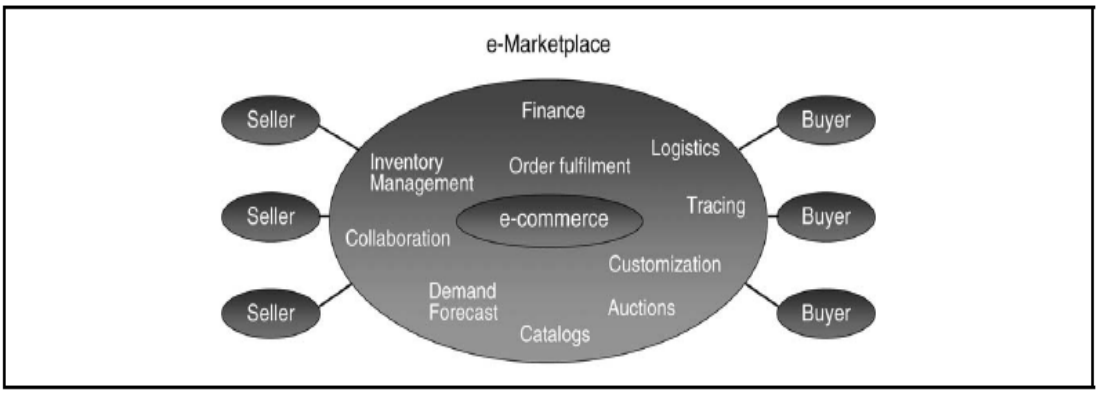


Fig.1.1. an Electronic Market Place Business Model [Brunn 2002]

Electronic markets' main characteristic is that the information phase of a market transaction is realized by means of a new information carrier, namely, the Internet. Lately new "electronic" functions, like electronic contracting tool or computer integrated logistics, were developed, in order to integrate all the phases of a market transaction. All this leads to the new concept of Electronic Market Place (EMP), which still is the subject of continuous and rapid developments.

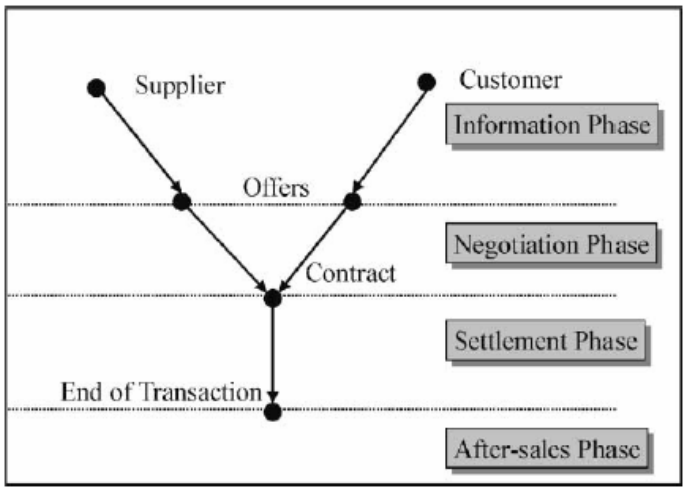


Fig.1.2. Transaction Phases of Electronic Market Perspective [Turban, 2006]

Many authors see electronic markets as a revolutionary development and some of them even identify EMPs with a new kind of economy: "the digital economy". Definitely, EMPs lead to a new way of competing and doing business. Therefore, we think that it would be appropriate to point out some of the major benefits and developments that EMPs provide, compared to the classic physical markets.

1.2.7. Classification of Electronic Commerce by the Nature of the Transactions or Interactions

Business to Business (B2B):

E-Commerce model in which all of the participants are businesses or other organizations.

Business to Customer (B2C)

E-Commerce model in which businesses sell to individual shoppers. In this thesis B@C form of electronic commerce will be mentioned.

E-tailing

Online retailing, usually B2C.

Business to Business to Customer (B2B2C)

E-Commerce model in which a business provides some product or service to a client business that maintains its own customers.

Customer to Business (C2B)

E-Commerce model in which an individuals use the internet to sell products or services to organizations or individuals seek sellers to bid on products or services they need. [Turban, 2006]

Customer to Customer (C2C)

E-Commerce model in which customer could sell directly to other customers.

1.3. Research Problem

The more effective the companies are in their website usability, the more complex they have become. For some organizations, they serve as repositories of information for the public. For others, websites also offer transaction capabilities, providing an additional mechanism to serve customers. Since websites serve as an important point of contact for most companies, assessing their effectiveness or *quality of the website* is critical, understanding whether the company is providing the satisfactory type and quality of information and interaction to its website users. This is especially true for companies selling goods and services on their websites. Customers' satisfaction with the website is a pivotal factor in customer churn matter of fact. Thus, the assessment of website quality has changed in to a highly prior factor in the success of companies.

1.4. Research Questions

Question that shall be answered in this thesis are:

The first to question is "to try to find out the parameters that affect on website quality and also to illustrate the relationship between these parameters and the quality of the website."

The second question is: "how to rank these parameters and how to comprehend which one has more effect on website quality?"

Chapter 2
Literature Review

2.1. Introduction

World is changing rapidly in order that business transactions, negotiation, settlement and business deals are changing excessively. Electronic buying and selling replace traditional commerce. The e-commerce has a potential to change channels in whole structure of businesses such as increasing business efficiency, enhancing information flows, improving transaction speed, wider geographical spread and etc [T.Harrison, 2006].A gate to show our identification in this virtual place is websites, because of this reason the number of brick and mortar organization selling costly and complex goods that are launching online initiatives to compete with pure-play online retailers' increase more and more every day [J.Etheir, 2006] and this means that business men were obliged to establish their own commercial websites that is define as a main part of electronic commerce. Commercial websites almost in every industry design with a less complex structure [Hakman, 2000] just to evaluate business functions versus customer values.

Having discussed websites, it is time to pay close attention to one of the form of commercial websites in electronic commerce which is B2C form of it and it directly related to buying and selling information, product and services via the internet and replace old channels to new online channels to customers [C.Dubelaar, 2005]. Customer has a significant role in B2C and allocated as a part of it. Nowadays creation of customer-centered website becomes more important. Trying to comprehend customer expectation and values about the websites is become essential indeed [Zhang, 2005].It is obvious that the success of B2C commercial websites closely related to

customers, new customers and repeat customers, and without a doubt the retention is more critical that attraction [Kotler, 2003].Customer satisfaction will make customer retention. Customer attractiveness may differ from each others and it deeply related to 1) internet experience and 2) innovation [F.Blake, 2005].

Now this question shall be answered that "what cause customer satisfaction in a website?" the answer is quality or in the better structure, website quality not only can have a major impact on number of visitors [Auger, 2005] but also can cause customer satisfaction. The higher website quality is, the higher business performance will be [Y.Lee, 2006].

The aim of this thesis is to find out complete meaning of website quality and to clarify the parameters which affect it just to discover a way to increase it and in follow to reserve a higher position for companies in e-commerce

2.2. Commercial Websites Specification's

The Most Commonly discussed type of e-commerce is B2C e-commerce, in which online business attempt to reach individual consumers [Laudon, 2003].

In Figure below the relationship between members who participate in B2C form of electronic commerce is completely illustrated. The main part is company and customers.

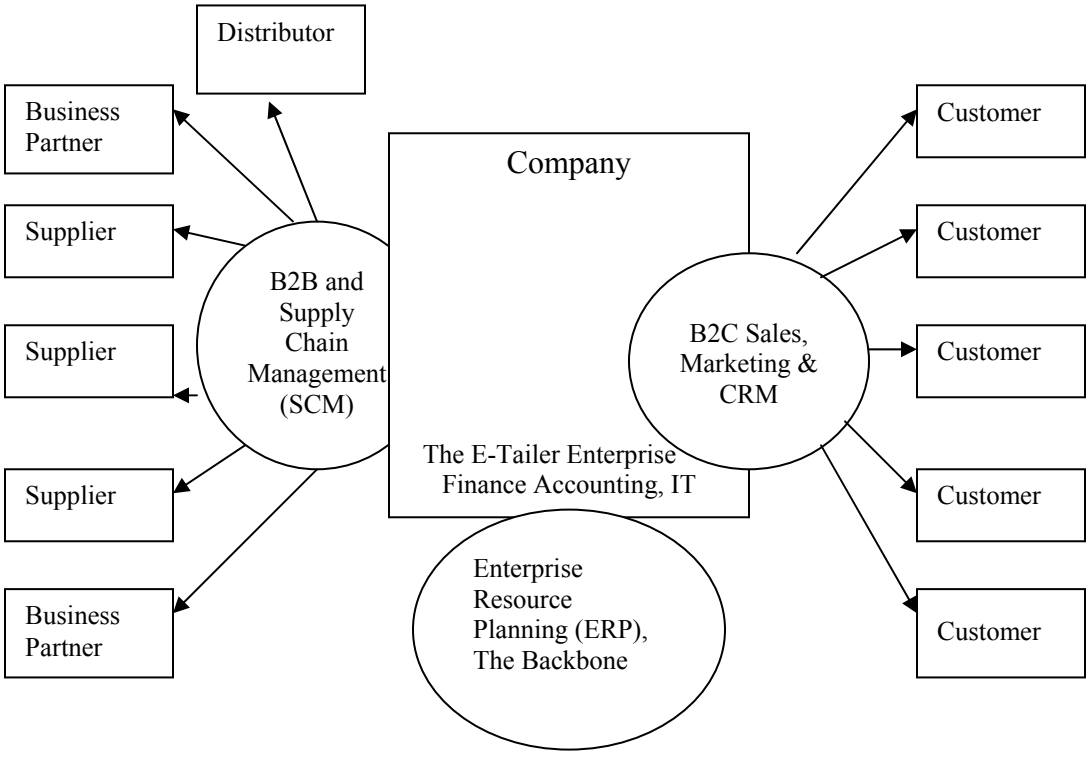


Fig.2.1. B2C (E-Tailing) as an enterprise electronic commerce system [Turban, 2006]

Although in literature, it is assumed as business partner and suppliers in the four units of right part of this figure, but writer made it all customers because in this paper the discussion is about

B2C form of business, commercial websites and quality that in all, the most important role is played with customers.

Knowing enough about B2C form of electronic commerce can lead to its entrance that is commercial websites. A website is a collection of web pages, typically common to a particular domain name or sub domain on the World Wide Web on the Internet. There are many varieties of web sites, each specializing in a particular type of content or use, and they may be arbitrarily classified in any number of ways. A few such classifications might include:

- Business site: used for promoting a business or service
- Commerce site or e-commerce site: for purchasing goods, such as Amazon.com
- Community site: a site where persons with similar interests communicate with each other, usually by chat or message boards, such as MySpace
- Political site: A site on which people may voice political views
- Database site: a site whose main use is the search and display of a specific database's content such as the internet movie database or the political graveyard

The phenomenal growth and use of the web during the last decade is providing fertile grounds for research activities. Since the web is a new medium for business interactions, service and product providers as well as infrastructure suppliers are searching for the most effective and competitive means to communicate with potential customers, motivate them to access or purchase their products and services, engender customer trust, and establish a leadership position by developing a competitive edge. The website is one of the entry facilitators or barriers in achieving these traditional goals in a new environment.

Having discussed about websites will directly make readers curious to find out website specific issues recently and its characteristic which all of them will be illustrated in the next pages. Based on literature review three important different items that each of them clarifies lots of angles of the website are founded. First of all is website quality, in this part quality, meaning and models for it are illustrated. In the second part in follow, website adoption and finally website loyalty which is essential to know more about it and to increase it will be mentioned. (Fig.2.2)

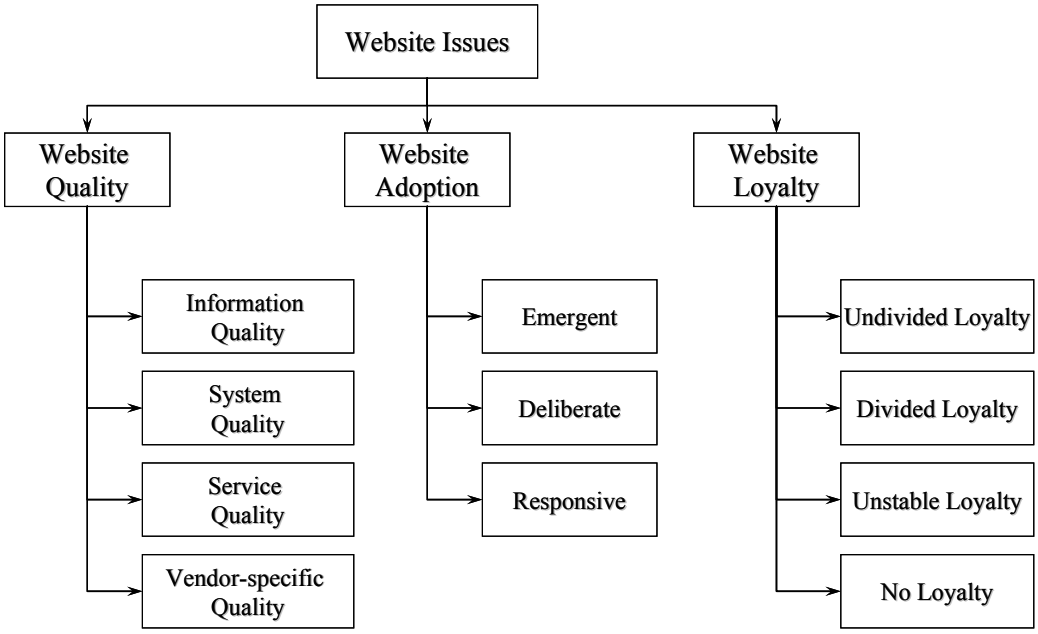


Fig.2.2: Website issues summary

2.3. Website Adoption

To illustrate website adoption, it could explain by below figure 12 that was mentioned with Chechen in 2006. It is completely obvious that almost 98% of top 1000 companies uses website for their commercial goals and just about 2% still don't have any website in united state. Nowadays merchandize without website is somehow going to bankruptcy.

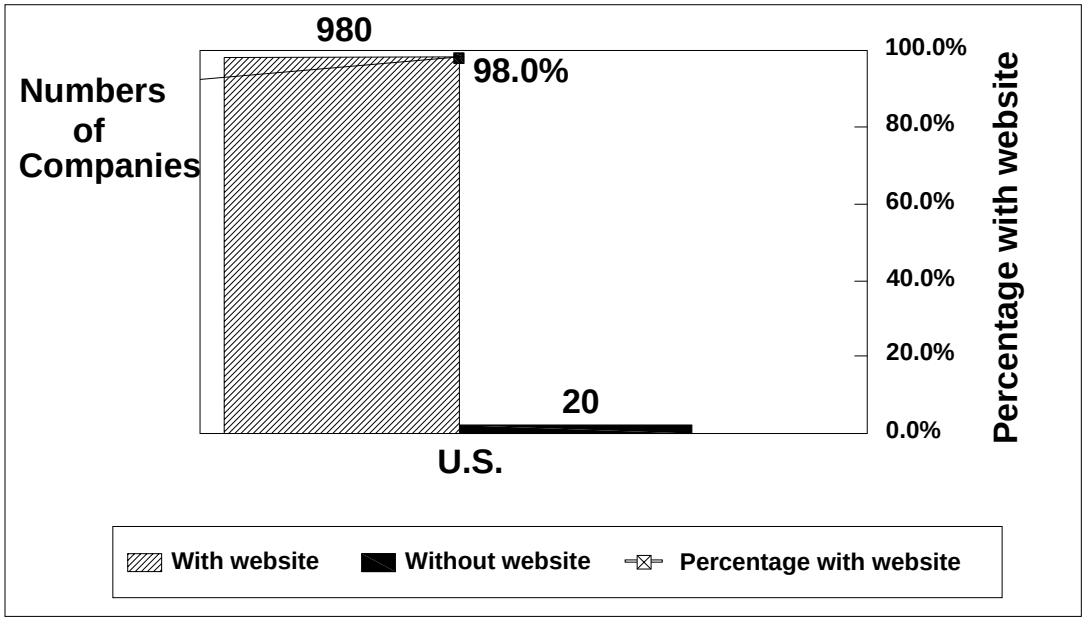


Fig.2.3. Web site presence of top 1000 companies in US, [Chechen Liao, 2006]

Such a finding reflects the fact that web technology has become well integrated into almost all American corporations. It has become a necessity to compete among competitors and to sustain a competitive position.
In the global web environment, understanding the practices of web adoption in various countries is becoming increasingly important.

The web adoption in the US has increased one-half (65% to 98%) since 1996. The growing trends show that the web in many countries has experienced an exponential increase and has had high acceptance in most organizations. Companies embrace the web for keeping prosperous and surviving. Web technology now provides better opportunities to establish a distinctive strategic position than did prior information technology. The web, for example, may bolster a company's competitive advantage by packaging and promoting unique products or services into distinctive styles. Hence, companies in different industries are encouraged to determine their own business practices on the web and to build a site suitable for their special purposes. This is especially true for companies, owing to the relative low percentage of web presence. With the strategic use of web technology, companies are able to coordinate online and offline efforts, add value to the business processes, and create new business models for reinforcing their own core competence [Liao, 2006].

Factors influencing website adoption are categorized as below:

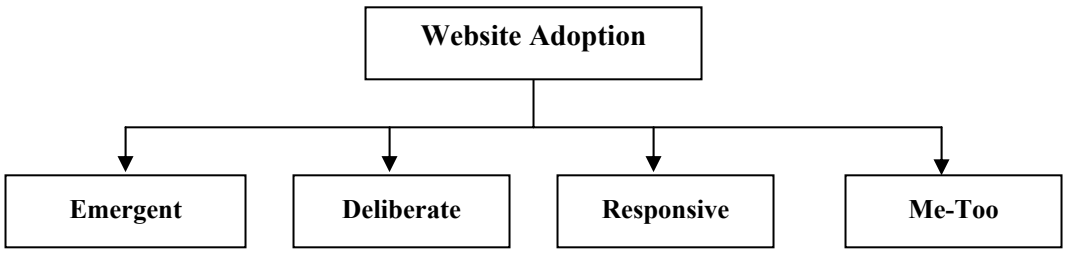


Fig. 2.4.Components of website adoption [T. Harrison, 2006]

2.3.1. Emergent

These items were all external influences and relate predominately to the opportunities created to develop a website or the fortuitous circumstances surrounding the website development. Hence, website development emerged as a result of them; it was not planned or guided but occurred serendipitously. It might be expected that the early majority, and perhaps some early adopters,

would be influenced most by such factors. The initial innovators would have already adopted the technology and external influences may then make use of marketing to widen participation in other segments providing opportunities for engagement.

2.3.2. Deliberate

These all related to a planned effort to develop a website that was managed and handled internally. Hence, it represented a deliberate effort to develop a website. It would expect that the innovators and early adopters would be influenced by this factor.

2. 3.3. Responsive

The two main items on which this factor loads are the expectations of clients (individual and corporate), however the influence of providers also shows a moderate loading in addition to factor 6.1. It would appear that companies have responded to the expectations of their clients (and perhaps other supply-chain members); hence this reflects a responsive developmental effort. We would expect the early and late majority to be the most influenced by this—as clients began to realize that companies offered web services, they would begin to expect it to be offered as a standard feature.

2.3.4. Me-too

The two main items loading on this factor related to the influence of competitors and the Internet boom, suggesting that website development was a reaction to the marketplace (imitation by potential adopters of their network partners who had previously adopted it). Such a strategy would be expected from the late majority and laggards.

2.4. Website Loyalty

Early views of loyalty focused on repeat purchase behavior. For example, Brown in 1952 classified loyalty into four categories, (1) Undivided loyalty, (2) Divided loyalty, (3) Unstable loyalty, and (4) No loyalty, based on the purchase patterns of consumers.

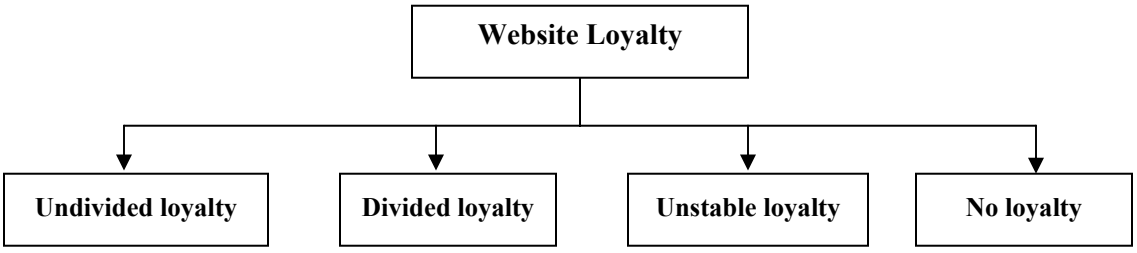


Fig.2.5.Components of website loyalty

Lipstein and Kuehn in 1962 measured loyalty by the probability of product repurchase. Some researchers have suggested that a behavioral definition is insufficient because it does not distinguish between true loyalty and spurious loyalty that may result, for example, from a lack of available alternatives for the consumer. In response to these criticisms, researchers have proposed measuring loyalty by means of an attitudinal dimension in addition to a behavioral dimension. Engel & Blackwell in 1982 defined brand loyalty as "the preferential, attitudinal and behavioral response toward one or more brands in a product category expressed over a period of time by a consumer." Jacoby in 1971 expressed the view that loyalty is a biased behavioral purchase process that results from a psychological process. According to Assael brand loyalty is "a favorable attitude toward a brand resulting in consistent purchase of the brand over time." This rationale was also supported by Keller, who suggested that loyalty is present when favorable attitudes for a brand are manifested in repeat buying behavior. Gremler in 1995 suggested that both the attitudinal and behavioral dimensions need to be incorporated in any measurement of loyalty. E-loyalty defines as a customer's favorable attitude toward the e-retailer that results in repeat buying behavior [Srinivasan, 2002].

Website loyalty transformation Aaker in 1996 stated that ''A loyal consumer base represents a barrier to entry, a basis for a price premium, time to respond to competitor innovations, and a bulwark against deleterious price competition''. More recently, consumers' attitudinal loyalty (i.e. commitment), has also been seen as the heart of customer relationship marketing. The importance of consumers' brand loyalty is thus acknowledged and researchers have shown great interests to extend it to the Internet market [Wang, 2006].

Researchers in general contend that consumers' positive brand attitude in the traditional market can be extended/ transferred to the brand's Website in the B2C e-commerce market. Similarly, Gommans et al. in 2001 indicated that consumers will extend their satisfactory past experiences with the brand in the traditional retail market to the brand's Website. Thus, the brand's website was perceived as an extension of the brand in the traditional retail market and a well-known brand's website was viewed as a quality promise in the B2C e-commerce market. In Ernst and Young's (1996) and Ward and Lee's (2000) surveys, up to 69% and 85.8% of those surveyed asserted that brand names played a significant role in their Internet buying decision.

2.5. Website Quality

According to Pat Augur (2005), the results indicate that the level of interactivity of a website is

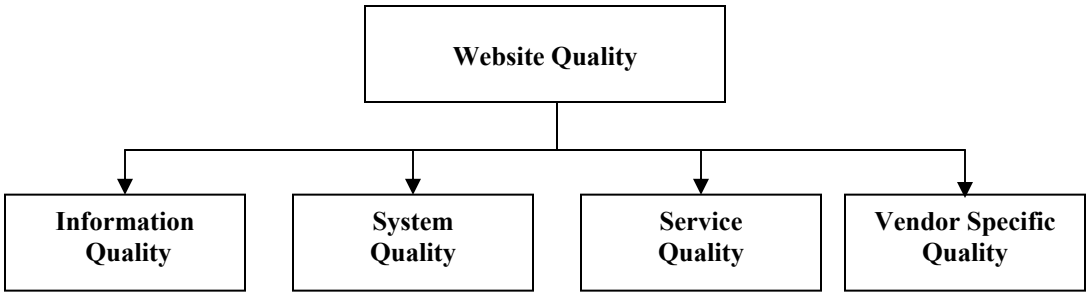


Fig.2.6. Major components of website quality

positively associated with overall performance, but not associated with the number of visitors. D. E. Rosen (2004) emphasized that web content has been identified as one of the main factors contributing to repeat visits. As content on the web includes text, pictures, graphics, layout, sound, motion and, someday, even smell, making the right web content decisions are critical to effective web design and then quality. Based on M. Fraquelli (2004), the quality is negatively affected by commercial interests, which are often undeclared. Soyoung Kim (2003) has said that how to compared five alternative models proposing relationships among 12 dimensions of website quality. The results supported their hypothesis that website quality for sites selling apparel products was conceptualized as a 12-dimensional construct rather than as a general construct. Zhang (2001) discusses building a theoretical framework for evaluating website quality from a user satisfaction perspective through theoretical and empirical investigations. Hakman (2000) mentioned a framework of analysis that categorizes features of website *design* in a matrix of business functions versus customer values. Fig. 2.6 proposes the main constructing factors of the B2C website.

The quality of the information that a system produces and delivers is considered to be a key factor. In the e-business context, website information quality insinuates delivering relevant, updated, and easy-to-understand information to significantly influence online customers' attitude, satisfaction, and purchases. It is proposed that the higher the quality of the website information, the more online customers would select that website for online shopping.

Information quality can be measured using information relevance, currency, and understandability. Information relevance includes relevant depth and scope, and completeness of the information. Currency includes updating of the information. Understandability includes ease of understanding and clearness of the information [Lee, 2006].Information quality based on literature review can be classified into four different major groups as are shown in Fig. 2.7.

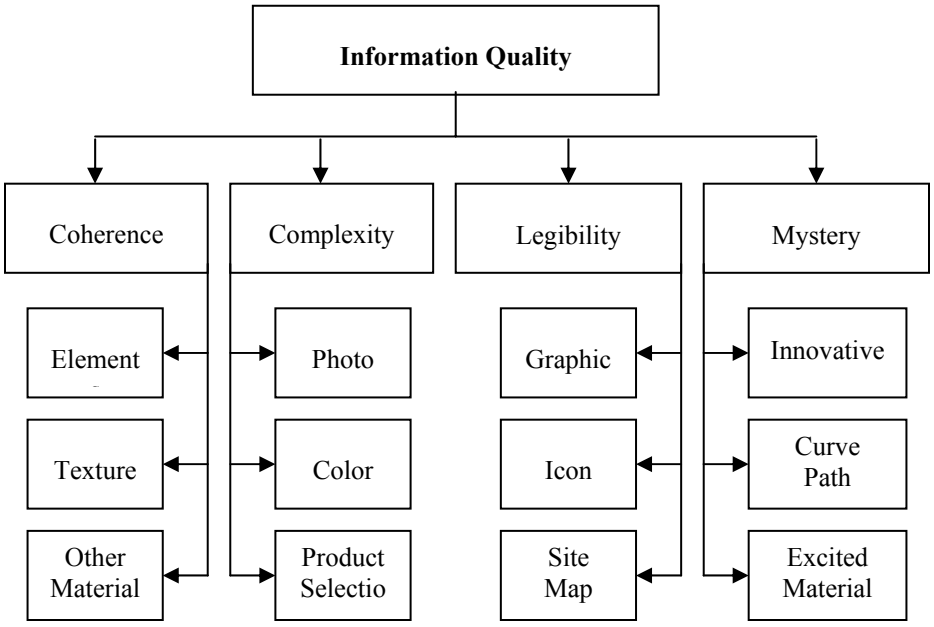


Fig.2.7. Components of information quality [Lee, 2006]

"Coherence" refers to the degree to which the environmental landscape hangs together. As such, coherence relies on redundancy of elements and textures. An example would be the coordinated colors in L.L. Bean's website (http://llbean.com). All of the colors in the menu bars and the products highlighted give an ''outdoorsy'' feel, utilizing shades of blue, green and brown.

Concerning the "Complexity", it refers to the richness of the elements in a setting. FTD's website (http://ftd.com) contains color photos of floral arrangements, product selection suggestions, short articles, as well as a left-hand menu bar for navigation. It is relatively easy to see how these first two dimensions can be related to website design. Through consistent deployment of a complementary color scheme or through variety in design elements, the user can make sense of and become interested in the Web-scape.

On the other hand, "Legibility" is defined by distinctiveness. By possessing a memorable component, a landmark, a scene facilitates finding one's way. In the web, this is similar to having

site map to make navigation of the website easier or having a distinctive graphic or icon that makes way-finding much more straightforward. For example, in L.L. Bean's website, the menubar remains positioned at the bottom of the screen no matter to what page one moves.

Finally, "Mystery" is used in landscape design, whereby a curved path is far more enticing than a straight one. Mystery enhances one's desire to explore a space by conveying the feeling that much more can be found if one keeps on going. Many websites try to establish ''mystery'' by having pages linked together not only mechanically but through the very content itself.

Making websites ''user friendly'' requires making them easy to use and understand. A web developer can use "coherence", "complexity", "legibility" and "mystery" to tap into the cognitive maps individuals employ to make sense of their world, and thus, building sites users feel comfortable returning to over and over again [Rosen, 2004].

Discussing the website quality issue, system quality, as the next main pillar for website quality, is defined as system performance in delivering information, also has been recognized as a critical success factor influencing technology use and user satisfaction. In the e-business context, website system quality has been known to have a significant effect on online customer satisfaction and online purchases. Customers dissatisfied with websites characterized by poor navigation, slowness, non-vividness, being unsecured, and with no personalized services are likely to leave the site even though the information provided by the website is of high quality [Lee, 2006].Based on literature review three main sub-categories for system quality are presented in Fig. 2.8.

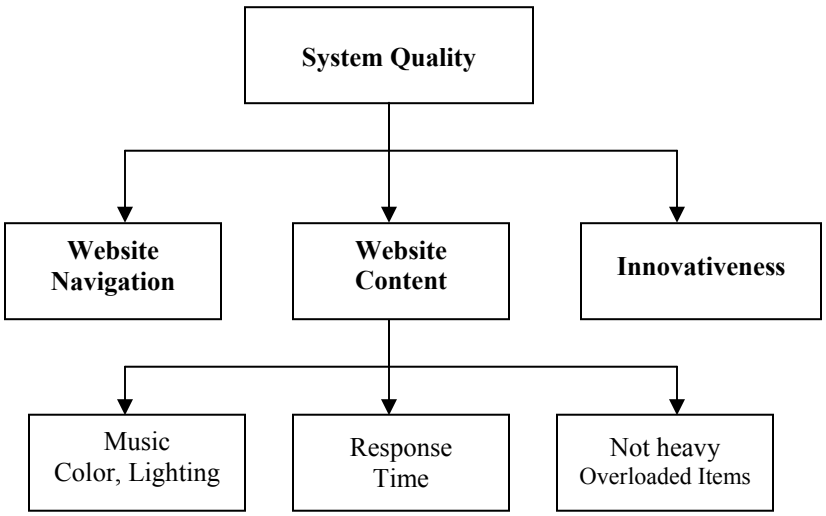


Fig.2.8. Components of system quality [Hakman, 2000, Woo Tan, 2006].

Concerning the "website navigation" issue in system quality module of website quality, commercial websites classified into six distinct types: online storefront, Internet presence, content, mall, incentive site, and search agent. Compared to the other categories, sites intended only for Internet presence are usually designed with a less complex structure. Although many are composed with hyperlinks and web pages in multimedia, they are just company brochures being digitized, referred to as flat ads or flag showing in.

Many companies are interested only in an easy entry to the Internet. Many reports have not been able to find sufficient evidence to prove that Web retailing can provide larger positive cash-flow than traditional business. These surveys suggested that Internet shopping is still in its infancy. The Tenth WWW User Survey by the Graphic, Visualization, & Usability Center shows that 42% of the respondents make a purchase from a Web-based vendor less than once per month.

The percentage of online shoppers only rises at a moderate rate; yet the multiplicative effect of the expanding population of Internet users might bring large revenues to Web business.

However, the advantages of Internet business are elusive. Just starting doing business on the Internet does not necessarily guarantee competitive advantage. A business website should thus be carefully designed; however, Schlosser and Kanfer point out that: many websites do not incorporate features that exploit the unique capabilities of the Internet; they lack navigational tools that could help visitors find the site and assess its beneficial features; and other promotional media are seldom integrated with online marketing strategies [Hakman, 2000]. The web pages form a network of text, graphics, etc. each of which should bear one or more definite purposes that are part of the company's strategy. To determine important features that aid in the success of

a particular business, it is appropriate to find a theoretical relationship between web features and the development direction of a business website.

Considering the "website content", as the next important pillar of system quality issue, there are evidences arguing that sensory stimuli such as music, color and lighting can influence the amount of time and money which a shopper spends in a retail establishment. For the e retailer, the sensory shopping experience must be played out on the template of the web page. Thus far, two of the most common ways used to measure website effectiveness are the number of ''eyeballs'' or click throughs. These measures merely capture how effective the firm's strategy is in regards to driving traffic to the site. To measure how effective a site is in terms of developing an appropriate e-retail sensory environment requires measuring the attitude toward the site design and intention to revisit. Website design presents a new challenge for marketers conversant in print media. Many elements of design and graphic art can be used to convey content on the web. The choices are truly endless. Elements of space, use of images, size of images, use of animation and/or audio, number of words per line, color and size of characters are among just a few of these factors. Additionally, the work of content design does not stop with selecting the appropriate elements for the particular audience. Content design also involves deciding on the placement of those elements to facilitate their use. Website design and usability has been widely studied academically. Palmer identified five measurements of website usability: download delay (i.e. access speed), navigation/organization, interactivity (i.e. customization), responsiveness (i.e. feedback and FAQ) and information content. Based on a questionnaire survey of 214 online shoppers, Ranganathan and Ganapathy empirically derived four key dimensions of business-to-consumer (B2C) Websites information content, design, security, and privacy that have an impact on the online purchase intent of consumers. Liu and Arnett found that learning capability, playfulness, system quality and system use are significant to well-designed B2C Websites [Rosen, 2004]. It is axiomatic that, if a commercial business-to consumer (B2C) website is to successfully generate sales, that website must have design that appeal to potential buyers. More specifically, various observers note that a site should be structured so as to attract consumers who are most likely to be the initial shoppers at websites.

A number of investigators propose that the initial online shoppers are those who are particularly innovative in this regard. Others have observed that those who shop online tend to be those who have more experience on the Internet. Given that the initial shoppers at a website are the more innovative and experienced users, the question then is how to structure a website so that it appeals to those potential buyers.

On the other hand, "Innovativeness" has been conceptualized and measured in a number of ways. One way is to see it as the degree to which an individual is earlier in adopting an innovation than

are other members of that social system. Another perspective is to identify innovativeness in terms of the number of innovations that one has adopted at a particular point in time. There has been criticism, however, of both the former 'time of adoption' and of the latter 'check list' viewpoint. Several investigators have considered this willingness to try new products and services to be a global or generalized readiness that cuts across a number of product/service classes. An alternate conceptualization is that of innovativeness as domain or product/service class specific. While one's domain specific innovativeness may at least partially flow from an underlying global/innate innovativeness, it is the domain specific form that usually has been found to be predictive of the adoption of numerous specific products/services [F.Blake, 2005].

"Service quality" refers to the overall support delivered by the Internet retailers. Service quality becomes more critical in e-business since online customers transact with unseen retailers.

Along with the three website quality factors discussed above, Internet "vendor-specific quality", the awareness of internet vendors and their reputation and price competitiveness, also has been considered an important e-business success factor [Lee, 2006].

2.6. Website Quality Model

The success of an e-business company is take place when its website is developed to provide the highest level of website quality among alternative websites and in follow online customers selecting a site as the most preferred website. The more customers select the website, the higher the likelihood of improved business performance [Lee, 2006] and it means that website quality factors significantly influence website selection and the most preferred website will generate the highest business performance. In this thesis, one of the main models for website quality will be discussed: The Kano model [Zhang, 2001]

2.6.1. The Kano Model for Quality

Kano, a Japanese management consultant and researcher, defined three levels of customer expectations for product and service quality that must be met for businesses to succeed: (1) Basic quality, (2) Performance quality, (3) Exciting quality.

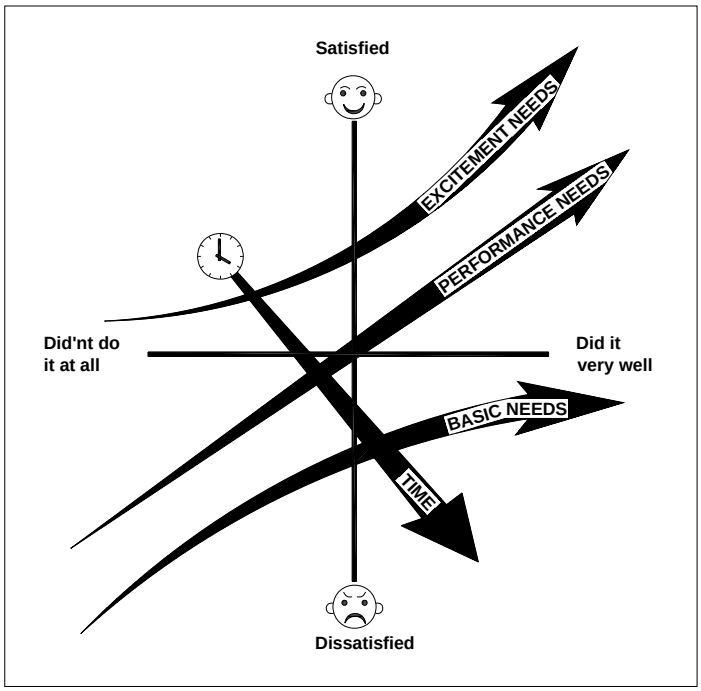


Fig.2.9: The Kano model [Zhang, 2001]

Basic quality is the minimum acceptable to the customer and encompasses those things that they take for granted and don't even think about. Their presence is not noticed, but their absence will generate complaints. When buying a car, for example, one assumes it has a functioning steering wheel, working brakes and lights etc. In terms of the level of customer service in a hotel, expected are clean towels and running hot and cold water.

Performance quality expectations are consciously stated needs. They include features that are typically used in TV commercials or other advertisements and that are discussed as quality items in a typical conversation among average customers. Their presence is consciously noted, while their absence is felt as a disappointment or as a disadvantage. The size and price of a car, the length of the warranty, and the rate for repairs are typical examples of performance quality. For hotel service example, the responsiveness and attentiveness of service personnel when checking out create either a sense of satisfaction or dissatisfaction - the less time a person has to wait in line and the more attention he/she receives, the more satisfied a guest will be.

Lastly, exciting quality examples are those features that delight customers and inspire loyalty. Since customers usually do not know the existence of nor have a conscious need for the exciting quality features, they will not miss them when they are not provided. Examples for cars may be side airbags, a built-in compass, a dashboard and steering wheel that imitate the cockpit of an

airplane, while a service example in a hotel may be the provision of a basket of fruit, bottled water, and shoe shining or ironing at no extra cost [Zhang, 2001].

The Kano Model assumes that with time and imitation by others, exciting quality features turn into normal expectations, and normal quality features migrate towards basic expectations. Fig. 2.3.6 depicts the essentials of the Kano Model.
In the web environment, the web (user interface) can be regarded as a service and users are consumers. They browse or “surf” the Internet, access, retrieve, and share information, interact with others over the Internet, order products or trade stocks, and obtain entertainment. A particular website delivers a special service. The quality of this service plays a similar role as the quality of services to consumers in other domains such as hospitals or hotels, or the customer service of a bookstore. However, without face-to-face human interaction in the web environment, service adjustments based on verbal or nonverbal (such as body language) cues are impossible. Thus design of the website is of even greater importance in delivering service [Zhang, 2001].

In order to have a systematic examination of features commonly used in quality website designs, it can used as the Kano Model to the web environment because it provides a parsimonious and easy to understand process of classifying known website features. Its major advantages over several other models originating in marketing fields are that the Kano model provides an easy to identify dimensions of quality and an explanation for the transition of features to different quality designations over time. The time element in Kano's model recognizes that perceptions of quality change after one purchased the product or used the services, or is more familiar with the product or service in general. This provides a more realistic timing of the assessment of quality; because the judgment is not based on the difference between expectation and the use of the product. Expectations might be highly unrealistic, based on insufficient information, and inexperience.

One of the most important advantages of the Kano model is that it identifies those quality features that fulfill unstated needs and those that make the products or services the market leaders. It is assumed that studying those "delighters" and the time it will take for their transition to become performance or basic quality features will be especially critical in the fast moving web environment. Another strength of Kano's model is the identification of those features that have to provide "basic quality", e.g. preconditions or antecedents for user satisfaction to occur and the understanding that the performance and delighter features may become such preconditions as time passes.

Thus (1) web design features can be categorized into three quality types in meeting three quality needs: basic, performance, and exciting. The *basic* features, those that are taken for granted and get the website "into the game," should support expected needs of users on a website. Examples could be active links and legibility. *Performance* features are those that get the website to "stay in the game" and thus contribute to the performance quality of the website. Links to related materials and support for different platforms are examples of normal features. Exciting features should make users delighted about the website, things they usually do not expect from a website but are excited when they see them. These features make the website "the leader in the game" and may generate user loyalty. An example of exciting features can be social feedback associated with using the website, such as a customer's reputation building that occurs on eBay.com as transactions occur. And (2) the quality types of features may change as time passes. Thus it is possible that some exciting features become performance features at a later time, and some performance features become basic features over time.

As in many literature mentioned they put website design as one of the major component of website quality and they discussed about it. By improving website design in follow website quality will be improved.

In continue the prepared taxonomy shows all parameters which affect on website quality entirely, so it will be broken down to small tables with complete description of each factor.

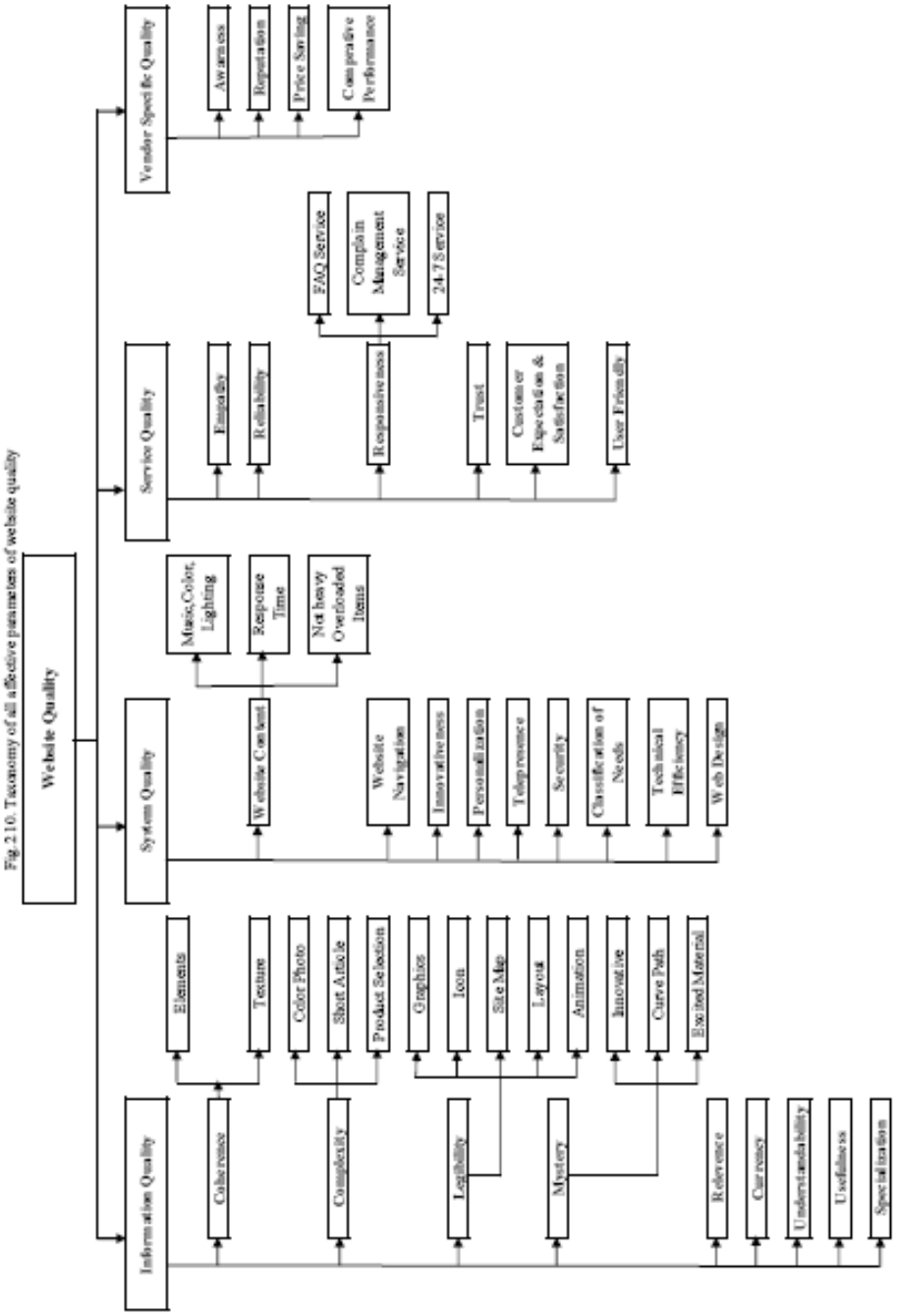


Fig 2.10: Taxonomy of all affective parameters of website quality

In this thesis the most important factors of website quality was discussed, so as bellow's tables all the definitions that is related to website quality will be described:

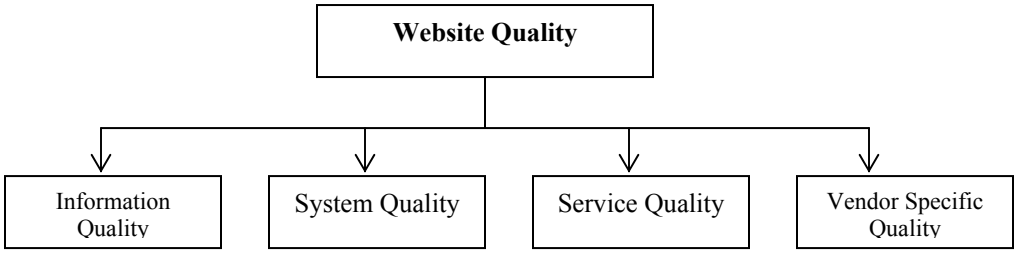


Fig.2.11. Website Quality Components

Information Quality:	The quality of the information that the system produces and delivers
System Quality:	System performance in delivering information, also has been recognized as a critical success factor influencing technology use and user satisfaction
Service Quality:	The overall support delivered by internet retailers & become more critical in e-business since online customers transact with unseen retailers
Vendor Specific Quality:	The awareness of Internet vendors and their reputation and price competitiveness

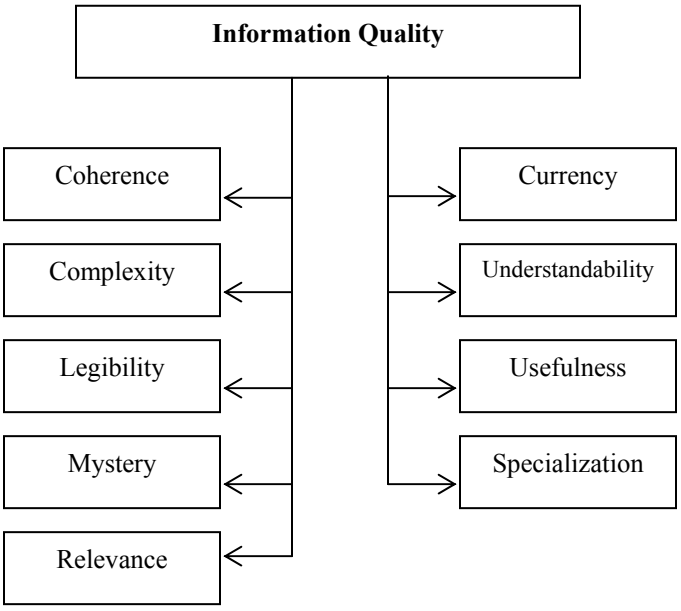


Fig.2.12. Information Quality Components

Information Quality:	The quality of the information that the system produces and delivers
Coherence:	Refers to the degree to which the environmental landscape hangs together, easy to understand & clear
Complexity:	Richness of the elements in a setting
Legibility:	Distinctiveness, by possessing a memorable component, a landmark, a scene facilitates finding one's way
Mystery:	Enhances one's desire to explore a space by conveying the feeling that much more can be found if one keeps on going
Relevance:	Relevant depth and scope, and completeness of the information
Currency:	The state of being in common or general use
Understandability:	Easy to understand
Usefulness:	Website has lots of benefits for users
Specialization:	Adjusted Related information

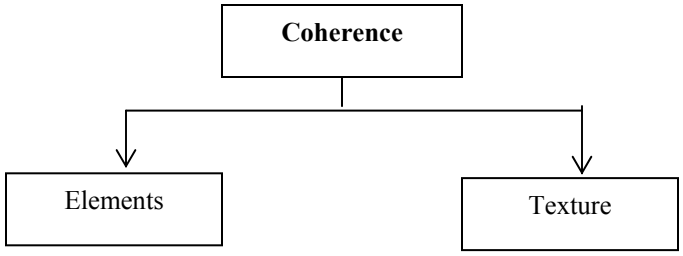


Fig.2.13. Coherence Components

Coherence:	Relies on redundancy of elements & texture
Elements:	A necessary or characteristic part of Something
Texture:	Background

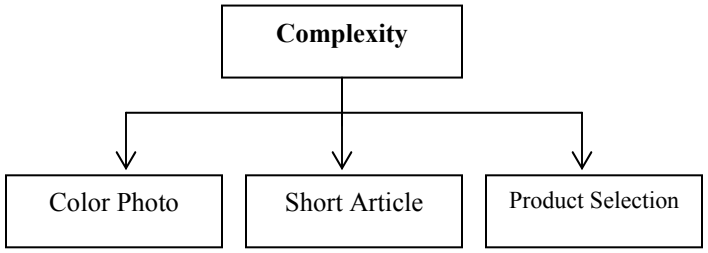


Fig.2.14. Complexity Components

Complexity: Refers to richness of the element in a setting

Color Photo: Colorful photograph, picture or snapshot

Short Article: To use short Item, object or paragraph

Product Selection: Collection of product available to choose

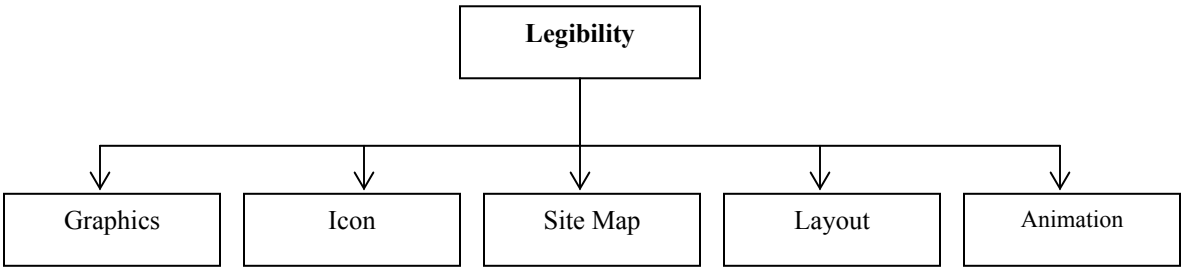


Fig.2.15. Legibility Components

Legibility: Defined by distinctiveness

Graphics: Makes way finding much more straight forward

Icon: Makes way finding much more straight forward

Site Map: Plan of the website

Layout: Context and colors

Animation: Shapes, cartoons

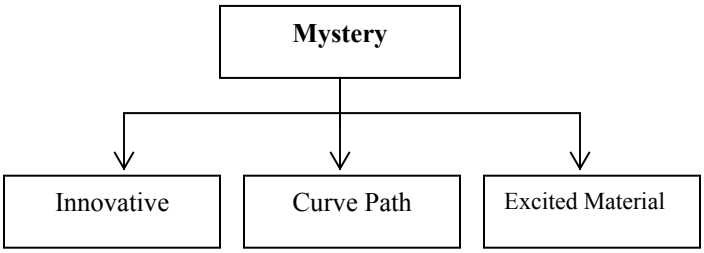


Fig.2.16. Mystery Components

Mystery: Enhances one's desire to explore a space by conveying the feeling that much more can be found if one keeps on going

Innovative: Using new, inventive items in a website

Curve Path: Using not straight, continuously bending line in designing a website

Excited Material: Using materials that arouse feelings

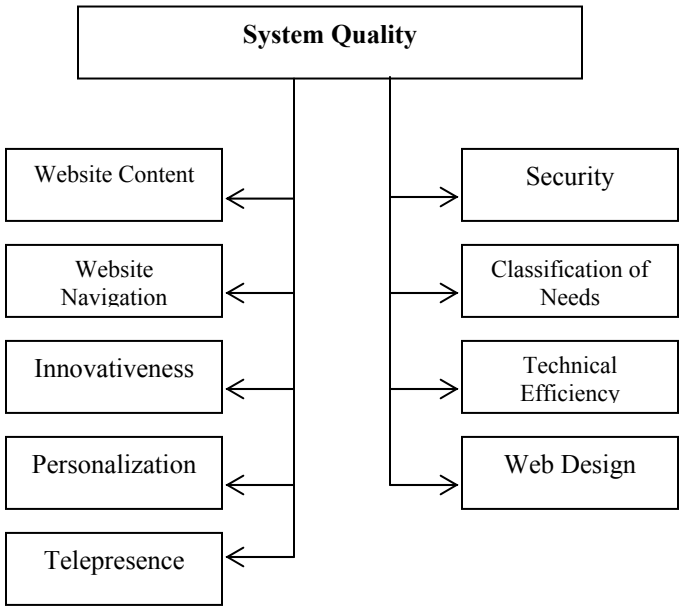


Fig.2.17. System Quality Components

System Quality:	System performance in delivering information, also has been recognized as a critical success factor influencing technology use and user satisfaction
Website Content:	All that is inside the website
Website Navigation:	Website's capability to provide alternative interaction and navigating techniques
Innovativeness:	Quality of introducing new things, creativity to the website
Personalization:	Making personal files for customers
Telepresence:	Sense of presence in the websites
Security:	Quality or state of being secure
Classification of Needs:	Basic , performance or excitement needs
Technical Efficiency:	Do the right things
Web Design:	Architecture of the website

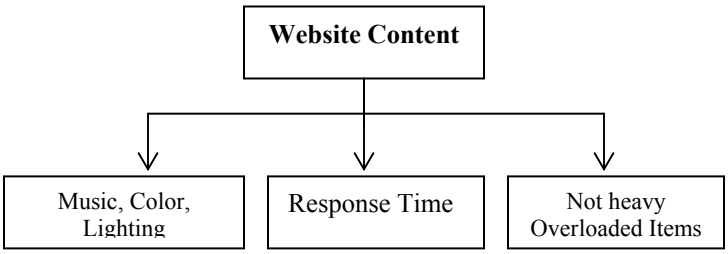


Fig.2.18. Website Content Components

Website Content: All that is inside the website

Music, Color, Lighting: All the visual elements in the website

Response Time: Time to reaction to customers

Not heavy Overloaded Items: Not to use excessively loaded items in website

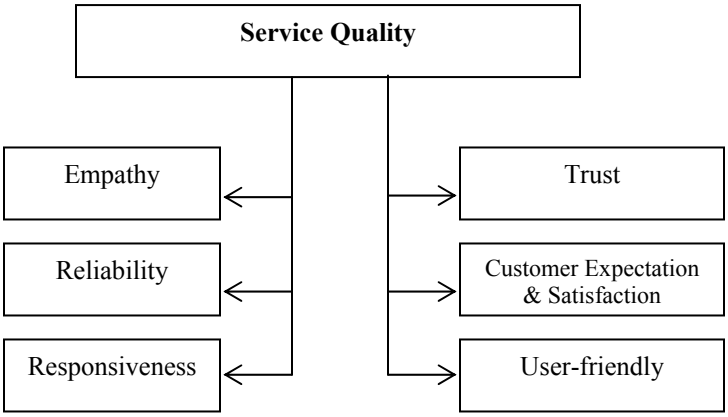


Fig.2.19. Service Quality Components

Service Quality: The overall support delivered by internet retailers & become more critical in e-business since online customers transact with unseen retailers

Empathy: Caring and attention the online retailer provides its customers

Reliability: Ability to perform the promised service dependably and accurately

Responsiveness: To be able to response to customer needs

Trust: Customer should have confidence to the website

Customer Expectation & Satisfaction: What customers really want

User-friendly: Easy to use & understand

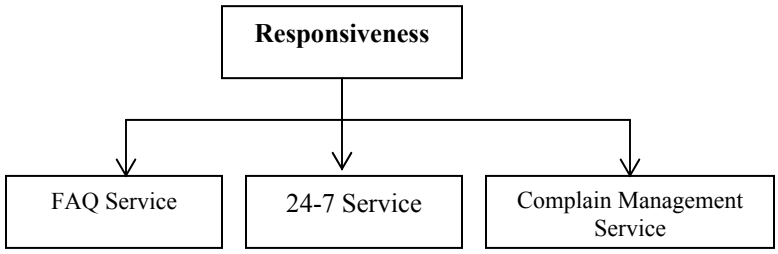


Fig.2.20. Responsiveness Components

Responsiveness: Quality of being quick to respond to customers

FAQ Service: Frequently Asked Question Service

24-7 Service: 24 hours-7days service

Complain Management Service: To consider the customer complain respectfully as soon as possible

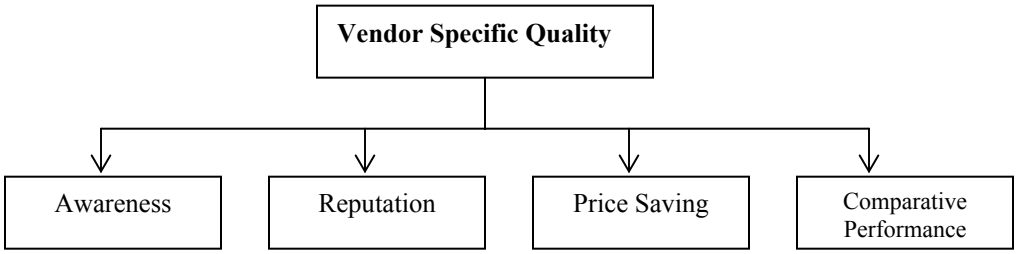


Fig.2.21. Vendor Specific Quality Components

Vendor Specific Quality: The awareness of Internet vendors and their reputation and price competitiveness

Awareness:	Existence of a critical mass who knows and experiences the website
Reputation:	Overall quality as seen or judged by online consumers
Price Saving:	Lower the cost of online purchasing
Comparative Performance:	Pay attention to performance of competitors

2.7. Conclusion

As a result, website quality is one of the main and also complex issues in evaluating the website. Finding some sensible models, helping us to develop a website with a higher level of quality is a hot matter of discussion in various research programs. There are many criteria that not only affect on website quality but also are so essential for quality of a commercial website. As the matter of fact, companies try to investigate on their website in order to compete with each other in the world of electronic commerce. Therefore increasing website quality and affective positive parameters on it, is more essential than any other times before. In this chapter website quality was separated in to four parts. The first part was information quality and the second part was system quality, in the third part there is a service quality and at the end vendor-specific quality. It was understood that these four parts also could separated into many small part too, that all of them illustrated in this chapter completely.

Chapter 3
Research Methodology

3.1. Introduction

After literature review and finding out the as many as possible parameters that effect on website quality in previous chapter, in this chapter the methodology of how to summarize these factors by making a suitable questionnaire and how to rank factors with an appropriate method in order to calculate each factor's weight will be completely illustrated.

3.2. Research Philosophy

Research philosophy of this thesis is to identify all quality parameters of B2C commercial websites in Iran by using fuzzy set method in order to avoid uncertainty and the chosen case study is e-bookshop. Accordingly, it is obvious that business to customer companies in Iran try to establish their own website and to transform their commerce into electronic commerce. The case study that was mentioned in this thesis is an e-bookshop because lots of e-bookshops just start to do the e-commerce in Iran recently. In order to test the web user, writer put the questionnaire of this thesis on the website of one of the most famous e-bookshop in Iran (bekhan.com) and gathered the data. In order to make the best result and avoid uncertainty, it would rather to use fuzzy set method

Fuzzy set theory base upon uncertainty and its method lead the research to make a more realistic outcome. There are lots of methods in fuzzy system but the two methods that were used in this thesis were fuzzy Technique for Order-Preference by Similarity to Ideal Solution (fuzzy TOPSIS)

and fuzzy analytical hierarchal process (fuzzy AHP).the first one is just for ranking all the parameters that are affective on website quality and the second one is to provide these factors weight. Although the first part will be started with normal TOPSIS, accordingly fuzzy TOPSIS with fuzzy numbers will be calculated.

3.3. Research Purpose

Exploratory is particularly useful when researchers lack a clear idea of the problems they will meet during the study. Through exploration researchers develop concepts more clearly, establish priorities, develop operational definitions, and improve the final research design. Exploration may also save time and money. If the problem is not as important as first thought, more studies can be canceled.

Exploration serves other purposes as well. The area of investigation may be so new or so vague that a researcher needs to do an exploration just to learn something about the dilemma facing the manager. Important variables may not be known or thoroughly defined. Hypothesis for the research may be needed. Also, the researcher may explore to be sure it is practical to do a formal study in the area.

Researchers and managers alike give exploration less attention that it deserves. There are strong pressures for quick answers. Moreover, exploration is sometimes liked to old biases about qualitative research: subjectiveness, nonrepresentativeness, and nonsystematic design. More realistically, exploration saves time and money and should not be slighted.

Qualitative techniques: the objectives of exploration may be accomplished with different techniques. Both qualitative and quantitative techniques are applicable, although exploration relies more heavily on qualitative techniques. One author creates a verbal picture to differentiate the two:

Quality is the essential character or nature of something: quantity is the amount. Quality is the what; quantity the how much. Qualitative refers to the meaning, the definition or analogy or model or metaphor characterizing something, while qualitative assumes the meaning and refers to a measure of it.

Descriptive Studies

In contrast to exploratory studies more formalized studies are typically structured with clearly stated hypotheses or investigative question. Formal studies serve a variety of research objectives:

1. Description of phenomena or characteristics associated with a subject population (who, what, when, where and how of a topic).

2. Estimated of the proportions of a population that has these characteristics.
3. Discovery of associations among different variables.

The third study objective is sometimes labeled a correlation study, a subset of descriptive studies. A descriptive study may be simple or complex; it may be done in many setting. Whatever the form, a descriptive study can be just as demanding of research skills as the casual study, and we should insist on the same high standards for design and execution.

Because the purpose of this research is to explore the parameters that are affective on website quality, so it would rather to call this thesis a kind of exploratory research.

3.4. Research Strategy

Research strategy is a general plan of how to answer the research questions that have beset (Saunders et al.2000). He outlined the research strategies that may be employed as follow:

- Experiment: classical form of research that owes much to the natural science and also social sciences, particularly psychology.
- Survey: usually associated with the deductive approach. It is a popular and common strategy in business research. They allow the collection of a large amount of data from a sizeable population in a highly economical way. Based most often on questionnaire, data are standardized and allow easy comparison.
- Case study: is of particular interest when the purpose is to gain a rich understanding of the context of the research and the processes begin enacted.
- Grounded theory: data collection starts without the formation of an initial theoretical framework. Theory is developed from data generated by a series of observations. These data lead to generation of predictions that are then tested in further observations.
- Ethnography: the purpose is to interpret the social world the research subjects inhabit in the way in which they interpret. This is obviously a research process that is very time consuming and take place over an extended time period.
- Action research: the researcher is part of the organization within which the research and change process are taking place.

This research is an example of a survey strategy in which questionnaire is replicated. The item in the questionnaire measured the most important parameters that affect on website quality and also using a case study that was an e-bookshop in Iran.

3.5. Collecting Data, Collecting Primary Data Using Questionnaire

(Saunders et al. 2000) note that the greatest use of questionnaires is made by the survey strategy. Questionnaires can therefore be used for descriptive research, such as that undertaken using attitude and opinion questionnaires and questionnaires of organizational practices, will enable us to identify and describe the variability in different phenomena.

3.5.1. Case Study

Case study of this thesis is bekhan.com which is one of the active e-bookshop in Iran. It should be mentioned that there is only seven or eight e-book shops in Iran but only a few of them are active and do the electronic commerce entirely.

Bekhan.com is one of the famous e-book shops in Iran. It was established by Fara cultural organization. The first aim of bekhan.com is high speed and easy access to the books through the website. The other important point about bekhan.com is that they support their customers with more than 20000 books from 500 different publishers.

Bekhan.com also covers all over the Iran and it can send a book to every cities of Iran. Bekhan.com also makes this possibility to have a book as a present for friends. The way of charging in bekhan.com is not only with smart cards but also in cash and it makes buying a book such an easy plan. (www.bekhan.com)

3.5.2 Questionnaire Design

Because of the reasons mentioned above writer used a questionnaire method for collecting primary data: the questionnaire was prepared by using taxonomy that was shown in the literature review part. All the affected parameters on website quality was mentioned in this taxonomy but because some parameters overlap with each other, therefore writer uses 22 parameters of 51 parameters of taxonomy in the making the questionnaire.

It had also five options (index) ranked by 1-5 for the raised questions could be found as follows:

1= not important 2=low important 3= average 4= important 5= very important

3.6. Pilot Testing

According to (Saunders et al. 2000) the purpose of the pilot test is to refine the questionnaire so that respondents will have no problems in answering the questions and there will be no problems in recording data.

For small-scale questionnaires, it is unlikely to have sufficient time or financial resources for such testing. However, it is still important to have the questionnaire pilot tested. For most questionnaires the minimum number for a pilot is 10 (Fink 1995).
As this questionnaire was not verified and used before, a pilot test was required; therefore a pilot test was done with 10 different experts in website quality subject. Having the pilot testing completed and feed back received, small changes were made through the questionnaire and it was going to be finalized.

3.7. Issues Regarding Validity and Reliability

According to Wiedersheim-Paul and Eriksson (1991) there are two common measurement problems that the researchers need to consider when determining if the study has been successful or not. These are reliability and validity. Reliability is the degree of accuracy of the collected data, i.e. if the study is repeated, the identical results were emerged.
Validity is concerned with if the researchers have studied what they intended to do and nothing else (Robson 1993).

To establish what sort of reliance and quality the research study is entitled to Yin (1994) propose four commonly used testing methods. These testing methods could be described as construct validity, internal validity, external validity and reliability.

- Internal validity: establishes a casual relationship in which certain conditions are shown to lead to other conditions, as distinguished from fake relationships.
- External validity: establishes the domain to which a study s finding can be generalized.
- Construct validity: establishes a correct operational measure for the concepts being studied.
- Reliability: demonstrating that the procedures of a study such as the data collection can be repeated by others with the same results.

Because this thesis is somehow a kind of exploratory research therefore internal validity wasn't necessary to be measured.

3.7.1 Reliability

This is about the results of the investigation, which has to be reliable. If nothing changes in a population between two investigations in the same purpose, it is reliable. From a deductive point

of view if the measure yields the same result on different occasions, or from an inductive point of view if similar observations be made be different researches on different occasions.
(Robson 1993) asserts that there may be four threats to reliability:

- Subject error: has to do with the interview is carried out, it is of grate importance to select a neutral time and date.
- Subject bias: is a grate problem in organizations where the management is of an authoritarian character where the interviewee(s) might say what the manager wants them to say, not what they feel.
- Observer bias: this is a question about how the interviewer interprets the data received.

A (Cronbach 1951) s Alpha value of 0.854 indicates reliability of the questionnaire.

Table 3.1: Reliability of the questionnaire

No. of Criteria	Cronbach's Alpha
22	0.854

3.7.2 Validity

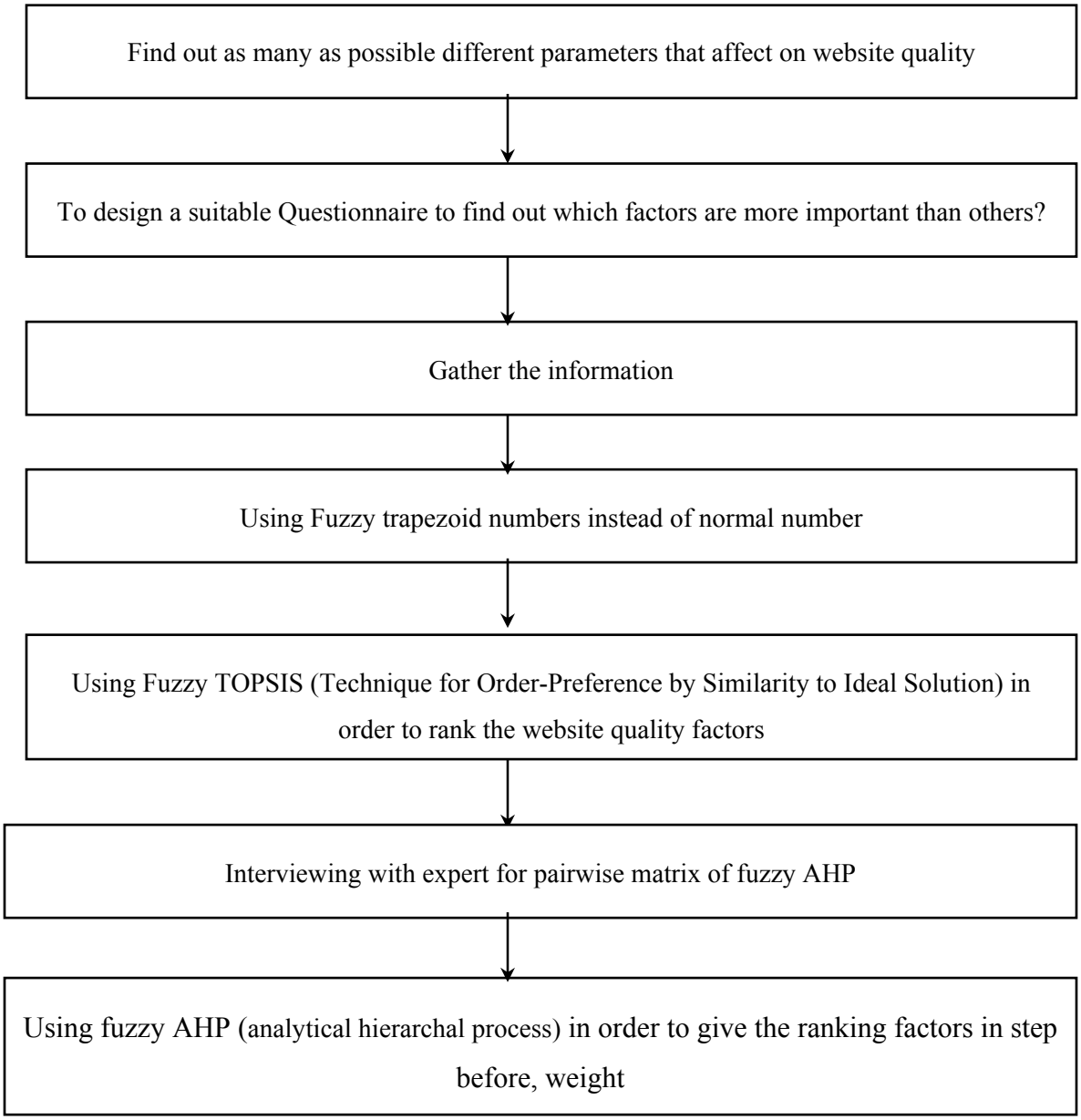
Validity is concerned with whether the findings are really about what they appear to be about (Saunders et al. 2000). There are three tests for validity:

- Construct validity: establishing correct operational measures for the concepts being studied.
- Internal validity: (for explanatory and casual studies only, not for descriptive or exploratory studied) establishing a causal relationship, whereby certain conditions are shown to lead to other conditions.
- External validity: establishing the domain to which a study s finding can be generalized.

If a question can be misunderstood, the information is said to be low validity. In order to avoid low validity, writer piloted the questionnaire after confirming the questionnaire by supervisor, with about 10 experts in the website quality subject, accordingly the validity was increased.

The **methodology** of the current thesis is shows in figure below; in the first part finding as many as possible affective factors on website quality is mentioned that in the literature review and in the last taxonomy each of them was illustrated completely. Because from 51 parameters in the taxonomy, lots of them overlap with each other, so in the designing a suitable questionnaire it converted to 22 parameters. Then interviewing with expert and also web users will be started to gather the related information and in the following steps, using fuzzy methods will begin. The two important fuzzy methods that will be used in this thesis are fuzzy TOPSIS and fuzzy AHP. The first one for ranking and the second one for giving the weigh to parameters were used.

Table 3.2 the schematic form of research methodology of this research



In the next part both of method that are going to be used in this thesis will be mentioned, the first part will be illustrated the normal TOPSIS with normal numbers, in the second part the fuzzy trapezoid numbers and fuzzy TOPSIS will be clarified and at last the fuzzy AHP will be demonstrated.

3.8. TOPSIS (Technique for Order-Preference by Similarity to Ideal Solution)

TOPSIS is a method that not also measures one point with the positive ideal but also measures it with negative ideal too. So the best point is the point that has a shortest distance from ideal and longest distance from negative ideal. TOPSIS method can be used with both normal numbers and fuzzy numbers. It is a method for ranking the parameters and in this thesis writer uses it to rank all the affective parameters on website quality which were about 22 parameters. At first normal TOPSIS with normal numbers was used and in the second fuzzy TOPSIS with the fuzzy numbers was used and finally, the result compare with each other. It is obvious that the fuzzy TOPSIS is more precisely than normal TOPSIS because it somehow shows the uncertainty better [M.J.Asgharpour, 1998].

The normal TOPSIS process described in follow:

First Step:

To change the decision matrix to this form:

$$n_{ij} = r_{ij} / \left(\sum_{i=1} (r_{ij})^2\right)^{1/2} \qquad (3.1)$$

n_{ij} stands for the score of each parameter which has been none scaled.

r_{ij} is stands for utility of each parameter.

Second Step:

To change the decision matrix to matrix like below:

$$W=\{w_1,w_2,w_3,\ldots\ldots w_n\}= \text{(from decision makers)} \qquad (3.2)$$

Where w stands for the weight of each item that was asked from decision makers

$$V=N_d * W_{n*n}= \begin{vmatrix} V_{11},\ldots. & V_{ii}\ldots.. & V_{1n} \\ V_{m1},\ldots. & V_{mj}\ldots.. & V_{mn} \end{vmatrix} \qquad (3.3)$$

V stands for the none scaled weight matrix

Third Step:

To specify positive ideal and negative ideal:

$$\text{Ideal} = A+ = \{(\max V_{ij}), (\max V_{ij}), i=1,2,..,m\} = \{V_1+, V_2+, \ldots V_n+\} \quad (3.4)$$

$$\text{Negative Ideal} = A+ = \{(\min x V_{ij}), (\min V_{ij}), i=1,2,..,m\} = \{V_1-, V_2-, \ldots V_n-\} \quad (3.5)$$

Fourth Step:

To calculated the distance:

$$\text{Distance i from Ideal} = \{\sum_{j=1}(V_{ij}-V_j+)^2\}^{0.5}, \quad i=1,2,..m \quad (3.6)$$

$$\text{Distance i from negative Ideal} = \{\sum_{j=1}(V_{ij}-V_j-)^2\}^{0.5}, \quad i=1,2,..m \quad (3.7)$$

Fifth Step:

Calculate distance between A_i and Ideal Solution

$$C_{li}+ = d_{i-}/(d_{i+}+d_{i-}) \quad (3.8)$$

$C_{li}+$ stands for the distance between A_i and Ideal Solution

3.9. Fuzzy TOPSIS

The approach is based on a fuzzy version of the "technique for order preference by similarity to ideal solution" (TOPSIS).The use of fuzzy logic theory allows one to avoid the intrinsic difficulty encountered in assessing "crisp" values in terms of the parameters.

Using fuzzy trapezoid numbers enabled the writer to change normal TOPSIS into fuzzy TOPSIS which is more precisely as the result shows in the next chapter.

The important relationship that shall be used in the fuzzy TOPSIS is the multiplying in fuzzy trapezoid numbers that are shown in below, the other part of fuzzy TOPSIS is like a normal TOPSIS with a small different that use fuzzy trapezoid numbers.

Suppose that there are two trapezoid number is like $D_1 = (a_1, b_1, c_1, d_1)$ and $D_2 = (a_2, b_2, c_2, d_2)$

M= Fuzzy trapezoid number $= D_1+D_2 = (a_1+a_2, b_1+b_2, c_1+c_2, d_1+d_2)$ (3.9)

$M^{/}$= Not a Fuzzy trapezoid number= $D_1*D_2 = (a (L_1, L_2), b, c, d (R_1, R_2))$ (3.10)

$a=a_1*a_2$ $L_1 = (b_1-a_1)*(b_2-a_2)$ (3.11)

$b=b_1*b_2$ $L_2 = a_2*(b_1-a_1)+a_1*(b_2-a_2)$ (3.12)

$c=c_1*c_2$ $R_1 = (d_1-c_1)*(d_2-c_2)$ (3.13)

$d=d_1*d_2$ $R_2= - [d_2 *(d_1-c_1)+d_1 *(d_2-c_2)]$ (3.14)

After ranking all the 22 parameters in the fuzzy TOPSIS with fuzzy numbers, now it is a time to calculate which factor is more important than others? To answer this question, it would rather to start the next phase of the calculation by using analytical hierarchal process or AHP that with fuzzy numbers, it converts to fuzzy AHP. In many research fuzzy AHP helps the researchers to find each element its weight more precisely. It is a way to find out which factor's weight is more than the others and how could we can rank the factors based upon their weight?

3.10. Fuzzy AHP

World around us is full of multi criteria decision making problems that everybody may interface with them during a day, an example of one of them is buying a house. Important criteria that are mentioned are: cost of house, culture of people who live in that region, easy access to the malls or our job, access to the educational centers for children and at last related expenditure. Now this question shall be considered that "if there are three different options for buying a house, which one will be the best decision to buy?"

In multi criteria decision making problems that will mentioned later, there are just quantitative criteria that will be mentioned, therefore for each problem there are limited criteria.

Many practical optimization problems are characterized by some flexibility in the problem constraints, where this flexibility can be exploited for additional trade-off between improving the objective function and satisfying the constraints. Especially in decision making, this type of flexibility could lead to workable solutions, where the goals and the constraints specified by different parties involved in the decision making are traded off against one another and satisfied to various degrees. Fuzzy sets have proven to be a suitable representation for modeling this type of soft constraints. Conventionally, the fuzzy optimization problem in such a setting is defined as the simultaneous satisfaction of the constraints and the goals. No additional distinction is assumed to exist amongst the constraints and the goals.

Many problems in decision making structure reality into constituent parts, that is, into hierarchical charts in which the goal is at the top, while the decisions are at the lowest level of the chart. At the intermediate levels of the chart are the various attributes and/or conditions which must be considered in order to arrive at a decision. A rather simplified hierarchal chart is given, in which the goal, all attributes and all possible decision occupy boxes in the hierarchal structure. The main idea in the analytical hierarchal process (AHP) approach is to construct a pairwise ranking of the boxes at any given level relative to the boxes at the next highest level to which they are connected. These pairwise rankings are used to constructed priorities which are then

combined to create and overall priority for each course of action under considerations. The course of action with the highest priority is then chosen. Uncertainly in the assigning of priorities and the use of semantic variables in their assignment lead naturally to the inclusion of fuzzy logic into the structure of the AHP paradigm.

3.10.1. Using Buckley Method

Analytical hierarchy process (AHP) is one of the most famous methods for solving multi criteria problems that was mentioned first by T.L.Saaty. He started to use Fuzzy AHP to make AHP more realistic and to take results more precisely.

Criteria in this method could be both quantitative and qualitative. There are about four steps in fuzzy AHP that were illustrated:

In this method, Trapezoid fuzzy number is a kind of number that we use.

For example: D_1= (5, 6, 8, 9) is like figure 3.1:

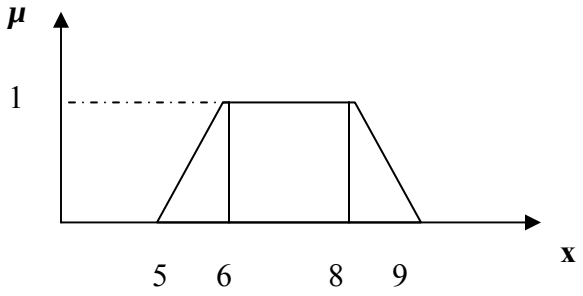


Fig.3.1. Fuzzy trapezoid number

3.10.2. Rules

$$\text{Average} = z_i = \{ \prod^{n}_{j=1} a_{ij} \}^{1/n} \quad (3.15)$$

Calculations between fuzzy Numbers are considered like this:

$D_1 = (a_1, b_1, c_1, d_1)$

$D_2 = (a_2, b_2, c_2, d_2)$

M= Fuzzy trapezoid number $= D_1 + D_2 = (a_1 + a_2, b_1 + b_2, c_1 + c_2, d_1 + d_2)$ (3.16)

$M^{/}$= Not a Fuzzy trapezoid number= $D_1 * D_2 = (a\ (L_1, L_2), b, c, d\ (R_1, R_2))$ (3.17)

$a = a_1 * a_2$ $L_1 = (b_1 - a_1) * (b_2 - a_2)$ (3.18)

$b = b_1 * b_2$ $L_2 = a_2 * (b_1 - a_1) + a_1 * (b_2 - a_2)$ (3.19)

$c = c_1 * c_2$ $R_1 = (d_1 - c_1) * (d_2 - c_2)$ (3.20)

$d = d_1 * d_2$ $R_2 = -[d_2 * (d_1 - c_1) + d_1 * (d_2 - c_2)]$ (3.21)

Therefore $\mu_M^{/}(x)$ are :

Table 3.3 the $\mu_M^{/}(x)$ for non -trapezoid fuzzy number

x	$\boldsymbol{\mu_M^{/}(x)}$
≤a	0
≥d	0
b≤x≤c	1
a≤x≤b	α € [0, 1]
c≤x≤d	α € [0, 1]

If a≤x≤b & $x_1= [a_1, b_1]$, $x_2= [a_2, b_2]$ so that: $x_i = (b_i-a_i)\ \alpha + a_i$

Then $x=x_1*x_2$ will be: $x=L_1\ \alpha^2 + L_2\ \alpha + a;\quad \alpha \in [0, 1]$ (3.22)

If c≤x≤d

Then $x=x_1*x_2$ will be: $x=R_1\ \alpha^2 + R_2\ \alpha + d;\quad \alpha \in [0, 1]$ (3.23)

c) The sum of fuzzy numbers like this: $[a_i\ (L_{i1}, L_{i2}), b_i, c_i, d_i\ (R_{i1}, R_{i2})]$

Is this form: Suppose two fuzzy numbers like this:

$M^{/}_1 = [a_1\ (L_{11}, L_{12}), b_1, c_1, d_1\ (R_{11}, R_{12})]$

$M^{/}_2 = [a_2\ (L_{21}, L_{22}), b_2, c_2, d_2\ (R_{21}, R_{22})]$

Therefore:

$M^{/}_1 + M^{/}_2 = M^{//} = \{(a_1+a_2)\ [L_{11}+L_{21}, L_{12}+L_{22}], (b_1+b_2), (c_1+c_2), (d_1+d_2)\ [R_{11}+R_{21}, R_{12}+R_{22}]\}$ (3.24)

& $\mu_M^{//}(x)$ is :

Table 3.4 the $\mu_M^{//}(x)$ for sum of two non -trapezoid fuzzy number

x	$\mu_M^{//}(x)$
$\leq(a_1+a_2)$	0
$\geq(d_1+d_2)$	0
$(b_1+b_2) \leq x \leq (c_1+c_2)$	1
$(a_1+a_2) \leq x \leq (b_1+b_2)$	$\alpha \in [0, 1]$
$(c_1+c_2) \leq x \leq (d_1+d_2)$	$\alpha \in [0, 1]$

c.1) If $(a_1+a_2) \leq x \leq (b_1+b_2)$ and it is understand from b.1. Point that $x=L_{i1}\ \alpha^2 + L_{i2}\ \alpha + a_i$

Therefore $x=x_1+x_2$ is like this form:

$$X= (L_{11}+L_{21})\ \alpha^2 + (L_{12}+L_{22})\ \alpha + (a_1+a_2) \qquad (3.25)$$

c.2) If $(c_1+c_2) \leq x \leq (d_1+d_2)$

Therefore $x=x_1+x_2$ is like this form:

$$X= (R_{11}+R_{21})\ \alpha^2 + (R_{12}+R_{22})\ \alpha + (d_1+d_2) \qquad (3.26)$$

3.10.3. Algorithm

First Step:

Find the pairwise matrix (A) form decision makers: $a_{ij}= (a_{ij}, b_{ij}, c_{ij}, d_{ij})$

Second Step:

Calculate w_i weight (geometrical average from each row of the A) using:

if $Zi= \{a_{i1}(0)\ a_{i2}(0)\ldots(0)a_{in}\}^{1/n}$: $\forall i$ then $wi = zi(:)(z_1 (+)z_2(+)\ldots.(+)\ z_n)$ (3.27)

Details of the w_i calculation are as below:

Right & left of fuzzy a_{ij} (in the crisp line L) were defined as equation:

$$f_i(\alpha) = [\prod^{n}_{j=1} (b_{ij} - a_{ij})\,\alpha + a_{ij}]^{1/n} \quad ; \quad \alpha \in [0, 1] \tag{3.28}$$

$$g_i(\alpha) = [\prod^{n}_{j=1} (d_{ij} - c_{ij})\,\alpha + c_{ij}]^{1/n} \quad ; \quad \alpha \in [0, 1] \tag{3.29}$$

Also:

$$a_i = \{\prod^{n}_{j=1} a_{ij}^{1/n}\} \quad ; \quad a = \sum^{m}_{i=1} a_i \tag{3.30}$$

$$b_i = \{\prod^{n}_{j=1} b_{ij}^{1/n}\} \quad ; \quad b = \sum^{m}_{i=1} b_i \tag{3.31}$$

$$c_i = \{\prod^{n}_{j=1} c_{ij}^{1/n}\} \quad ; \quad c = \sum^{m}_{i=1} c_i \tag{3.32}$$

$$d_i = \{\prod^{n}_{j=1} d_{ij}^{1/n}\} \quad ; \quad d = \sum^{m}_{i=1} d_i \tag{3.33}$$

Therefore: weight of w_i is like:

$$w_i = (a_i/d\,,\ b_i/c\,,\ c_i/b\,,\ d_i/a) \quad ; \quad \forall i \tag{3.34}$$

Then $\mu\, w_i(x)$ defined as:

Table 3.5 the $\mu\, w_i(x)$ for w_i (weight)

x	$\mu\, w_i(x)$
$\leq (a_i/d)$	0
$\geq (d_i/a)$	0
$[b_i/c\,,\ c_i/b]$	1
$[a_i/d\,,\ b_i/c]$	$\alpha \in [0, 1]$
$[c_i/b\,,\ d_i/a]$	$\alpha \in [0, 1]$

If $x \in [a_i/d, b_i/c]$ therefore $x = f_i(\alpha) / g_i(\alpha)$ so $f(\alpha) = \sum^{m}_{i=1} f_i(\alpha)$ (3.35)

If $x \in [c_i/b, d_i/a]$ therefore $x = g_i(\alpha) / f_i(\alpha)$ so $g(\alpha) = \sum^{m}_{i=1} g_i(\alpha)$ (3.36)

Third Step:

Repeat the second step for calculating n_{ij} for all of a_{ij} and w_i.

Fourth Step:

For fuzzy u_i: $U_i = \sum^{n}_{i=1} w_{i*} n_{ij}$; $\forall i$ (3.37)

U_i Should be calculated for many times that is necessary for the problem.

3.11. Conclusion

Finally, by using fuzzy AHP, the weight of each factor can be calculated and the ranking based upon the weight could be possible. At the end of next chapter, it is possible to have a schedule that rank eight of most important affected parameters on website quality by their weight that the weight will implicated on the importance or preference of the parameters.

AHP helps the research to have these three items:

- To build a ranking fundamental for each problem
- To show the preference based upon the pairwise
- To cause a logic consistency from measurements

In the problems that has lots of parameters like the problem of this thesis, AHP helps a lot in order to avoid commotion and to make ranking fundamental in order to have a better comprehension of the problem and to have a better and easier analyzing of it. Besides using fuzzy set theory enable the writer to have a more realistic conclusion at the end.

Chapter 4
Data Gathering & Data Analysis

4.1. Introduction

In previous chapter, all parameters that affect on website quality was clarified by a taxonomy completely and also it was mentioned that how to rank these factors and also how to give them weight. Weight is significant because by weight the preference of each criteria among others will be appear but it will not possible in the first steps that using TOPSIS method. TOPSIS method is a kind of method that use in order to rank parameters and to arrange them regular. TOPSIS is a method that finds both ideal and negative ideal among the parameters, accordingly; ranks the criteria by measuring the distance between these two points. The best rank will goes to the criteria that have a shortest distance with ideal point and longest distance with a negative ideal.

In the second phase of the calculation in this chapter, AHP will use in order to all of the ranking parameters to have their own weight and AHP make it possible for each parameter to have a weight based upon the area under the curve. It is obvious that by using fuzzy trapezoid numbers, the curve will appears and it has its area under the curve, by calculation this area the weight of each parameter will be estimated.

4.2. TOPSIS (Technique for Order-Preference by Similarity to Ideal Solution)

TOPSIS is a method that not also measures one point with the positive ideal but also measures it with negative ideal too. So the best point is the point that has a shortest distance from ideal and longest distance from negative ideal. TOPSIS method can be used with both normal numbers and fuzzy numbers. It is a method for ranking the parameters and in this thesis writer uses it to rank all the affective parameters on website quality which were about 22 parameters. At first normal TOPSIS with normal numbers was used and in the second fuzzy TOPSIS with the fuzzy numbers was used and finally, the result compare with each other. It is obvious that the fuzzy TOPSIS is more precisely than normal TOPSIS because it somehow shows the uncertainty better.

The normal TOPSIS process described in follow:

Table .4.1 the result of questionnaire

	Not important	**Low important**	**Average**	**Important**	**Very important**
Question No. ↓	**1**	**2**	**3**	**4**	**5**
1	2	0	15	20	33
2	0	5	28	30	7
3	0	10	30	20	10
4	12	14	10	14	19
5	4	6	26	22	11
6	0	3	15	28	24
7	3	7	35	22	3
8	1	6	14	23	26
9	4	10	22	26	6
10	0	0	10	15	45
11	1	4	12	13	40
12	0	1	11	25	33
13	0	3	17	31	19
14	1	4	28	22	13
15	2	1	3	12	52
16	2	3	20	28	17
17	3	3	12	23	29
18	13	11	17	15	14
19	2	2	17	28	20
20	5	6	13	26	19
21	4	2	16	20	28
22	3	4	33	23	6

Table.4.1. shows the results that were taken from the questionnaires; about 70 web users fill the questionnaire. In the tables rows stand for the questions about website quality that were 22 questions and columns stands for the 5 degree about each question.(1= not important, 2=low important ,3=average, 4=important ,5=very important).

First Step:

To change the decision matrix to this form:

$$n_{ij} = r_{ij} / (\sum_{i=1} (r_{ij})^2)^{1/2} \quad (4.1)$$

n_{ij} stands for the score of each parameter which has been none scaled.
r_{ij} is stands for utility of each parameter.

Table.4.2. first process on the result of questionnaire by multiply each cell by itself

	Not important	**Low important**	**Average**	**Important**	**Very important**
Question No. ↓	**1**	**2**	**3**	**4**	**5**
1	4	0	225	400	1089
2	0	25	784	900	49
3	0	100	900	400	100
4	144	196	100	196	361
5	16	36	676	484	121
6	0	9	225	784	576
7	9	49	1225	484	9
8	1	36	196	529	676
9	16	100	484	676	36
10	0	0	100	225	2025
11	1	16	144	169	1600
12	0	1	121	625	1089
13	0	9	289	961	361
14	1	16	784	484	169
15	4	1	9	144	2704
16	4	9	400	784	289
17	9	9	144	529	841
18	169	121	289	225	196
19	4	4	289	784	400
20	25	36	169	676	361
21	16	4	256	400	784
22	9	16	1089	529	36
Sum	**432**	**793**	**8898**	**11388**	**13872**
SQRT	**20.8**	**28.2**	**94.3**	**106.71457**	**117.7795**

Table.4.2. shows the first process of the TOPSIS method that each cell should multiply by itself and put the result in its own cell then for each column sum would be calculated and accordingly the square of the number of the sum would estimated.

Table.4.3. Second process step by dividing each cell of last table on related square (SQRT)

Question No. ↓	n_{ij}				
	1	**2**	**3**	**4**	**5**
1	0.19	0	2.39	3.75	9.25
2	0	0.89	8.31	8.43	0.42
3	0	3.55	9.54	3.75	0.85
4	6.93	6.96	1.06	1.84	3.07
5	0.77	1.28	7.17	4.54	1.03
6	0	0.32	2.39	7.35	4.89
7	0.43	1.74	13	4.54	0.08
8	0.05	1.28	2.08	4.96	5.74
9	0.77	3.55	5.13	6.33	0.31
10	0	0	1.06	2.11	17.2
11	0.05	0.57	1.53	1.58	13.6
12	0	0.04	1.28	5.86	9.25
13	0	0.32	3.06	9.01	3.07
14	0.05	0.57	8.31	4.54	1.43
15	0.19	0.04	0.1	1.35	23
16	0.19	0.32	4.24	7.35	2.45
17	0.43	0.32	1.53	4.96	7.14
18	8.13	4.3	3.06	2.11	1.66
19	0.19	0.14	3.06	7.35	3.4
20	1.2	1.28	1.79	6.33	3.07
21	0.77	0.14	2.71	3.75	6.66
22	0.43	0.57	11.5	4.96	0.31

Each cell of the column should divided on the square of related column so by dividing all numbers of table 4.2. It will change it to table 4.3. (For example in the frits unit: 4 divide to 20.8 =0.19)

Table.4.4. the matrix of weight that were calculated by Entropy method

$$W=\begin{vmatrix} 0.03261 & 0 & 0 & 0 & 0 \\ 0 & 0.21781 & 0 & 0 & 0 \\ 0 & 0 & 0.25029 & 0 & 0 \\ 0 & 0 & 0 & 0.25952 & 0 \\ 0 & 0 & 0 & 0 & 0.23978 \end{vmatrix}$$

After doing the second process of TOPSIS, it is a time to have a 5*5 matrix which all units of it, will be zero expect the diameter units that is because the numbers are the weight that calculated by Entropy method. Then these two tables (4.3. and 4.4.) should multiply by each other like a matrix multiply method.

Second Step:

To change the decision matrix to matrix like below:

$$W=\{w_1,w_2,w_3,\ldots\ldots w_n\}= \text{(from decision makers)} \quad (4.2)$$

Where w stands for the weight of each item that was asked from decision makers

$$V= N_d*W_{n*n}= \begin{vmatrix} V_{11},\ldots. & V_{ii}\ldots.. & V_{1n} \\ V_{m1},\ldots. & V_{mj}\ldots.. & V_{mn} \end{vmatrix} \quad (4.3)$$

V stands for the none scaled weight matrix

Table.4.5. the matrix of multiply of tables 4.3 by matrix 4.4.

$$V = \begin{vmatrix} 0.006276 & 0 & 0.597002 & 0.972756 & 2.217016 \\ 0 & 0.193362 & 2.080219 & 2.188701 & 0.099756 \\ 0 & 0.773449 & 2.388007 & 0.972756 & 0.203583 \\ 0.225931 & 1.515961 & 0.265334 & 0.47665 & 0.734934 \\ 0.025103 & 0.278442 & 1.793658 & 1.177035 & 0.246335 \\ 0 & 0.06961 & 0.597002 & 1.906602 & 1.172637 \\ 0.014121 & 0.37899 & 3.250342 & 1.177035 & 0.018322 \\ 0.001569 & 0.278442 & 0.520055 & 1.28647 & 1.376219 \\ 0.025103 & 0.773449 & 1.284217 & 1.643958 & 0.07329 \\ 0 & 0 & 0.265334 & 0.547175 & 4.12255 \\ 0.001569 & 0.123752 & 0.382081 & 0.410989 & 3.257324 \\ 0 & 0.007734 & 0.321054 & 1.519931 & 2.217016 \\ 0 & 0.06961 & 0.766815 & 2.337047 & 0.734934 \\ 0.001569 & 0.123752 & 2.080219 & 1.177035 & 0.344055 \\ 0.006276 & 0.007734 & 0.02388 & 0.350192 & 5.504877 \\ 0.006276 & 0.06961 & 1.061336 & 1.906602 & 0.588354 \\ 0.014121 & 0.06961 & 0.382081 & 1.28647 & 1.712131 \\ 0.265155 & 0.935874 & 0.766815 & 0.547175 & 0.399022 \\ 0.006276 & 0.030938 & 0.766815 & 1.906602 & 0.814331 \\ 0.039224 & 0.278442 & 0.448415 & 1.643958 & 0.734934 \\ 0.025103 & 0.030938 & 0.679255 & 0.972756 & 1.596089 \\ 0.014121 & 0.123752 & 2.889488 & 1.28647 & 0.07329 \end{vmatrix}$$

Table 4.5. shows the multiply of tables 4.3. by matrix 4.4. Therefore the numbers in table 4.3 by multiply to the weight in table 4.4 converted to the weights that will processed on it in order to make maximum and minimum of the weights.

Third Step:

To specify positive ideal and negative ideal:

$$\text{Positive Ideal} = A+ = \{(\max V_{ij}), (\max V_{ij}), i=1,2,..,m\} = \{V_1+, V_2+, \ldots V_n+\} \quad (4.4)$$

$$\text{Negative Ideal} = A+ = \{(\min x V_{ij}), (\min V_{ij}), i=1,2,..,m\} = \{V_1-, V_2-, \ldots V_n-\} \quad (4.5)$$

Table.4.6 max and min of each column in table 4.5.

A+

max Vi1	max Vi2	max Vi3	max Vi4	max Vi5
0.265155	1.515961	3.250342	2.337047	5.504877

A-

min Vi1	minVi2	minVi3	minVi4	minVi5
0	0	0.02388	0.350192	0.018322

As doing the process steps in TOPSIS, it is time to have ideal and negative Ideal of table 4.5 that shows completely in table 4.6, this table shows the maximum and the minimum of each column of previous table in two rows. A+ is all the maximum numbers and A- is all the minimum numbers.

Forth Step:

To calculated the distance:

$$\text{Distance i from Ideal} = \{\sum_{j=1}(V_{ij}-V_j+)^2\}^{0.5} \quad , i=1,2,..m \quad (4.6)$$

$$\text{Distance i from negative Ideal} = \{\sum_{j=1}(V_{ij}-V_j-)^2\}^{0.5} \quad , i=1,2,..m \quad (4.7)$$

Now it is time to minus each cell on table 4.5 from maximum and minimum of related column in table 4.6. So in consequence table 4.7 and also table 4.9 will be appear that makes this part of formula $(V_{ij}-V_j-)^2$ then in continue sum will be needed.

Table.4.7. the forth step in TOPSIS method (it has five parts)-distance between max point and each point

(Vij- Vj+)	(Vij- Vj+)^2
-0.25888	0.067019
-0.26516	0.070307
-0.26516	0.070307
-0.03922	0.001539
-0.24005	0.057625
-0.26516	0.070307
-0.25103	0.063018
-0.26359	0.069478
-0.24005	0.057625
-0.26516	0.070307
-0.26359	0.069478
-0.26516	0.070307
-0.26516	0.070307
-0.26359	0.069478
-0.25888	0.067019
-0.25888	0.067019
-0.25103	0.063018
0	0
-0.25888	0.067019
-0.22593	0.051045
-0.24005	0.057625
-0.25103	0.063018

(Vij- Vj+)	(Vij- Vj+)^2
-1.51596	2.298138
-1.3226	1.749267
-0.74251	0.551323
0	0
-1.23752	1.531454
-1.44635	2.09193
-1.13697	1.292703
-1.23752	1.531454
-0.74251	0.551323
-1.51596	2.298138
-1.39221	1.938246
-1.50823	2.274747
-1.44635	2.09193
-1.39221	1.938246
-1.50823	2.274747
-1.44635	2.09193
-1.44635	2.09193
-0.58009	0.336501
-1.48502	2.205293
-1.23752	1.531454
-1.48502	2.205293
-1.39221	1.938246

(Vij- Vj+)	(Vij- Vj+)^2
-2.65334	7.040216
-1.17012	1.369188
-0.86234	0.743623
-2.98501	8.910274
-1.45668	2.121928
-2.65334	7.040216
0	0
-2.73029	7.45447
-1.96613	3.865649
-2.98501	8.910274
-2.86826	8.226922
-2.92929	8.580728
-2.48353	6.167905
-1.17012	1.369188
-3.22646	10.41006
-2.18901	4.791747
-2.86826	8.226922
-2.48353	6.167905
-2.48353	6.167905
-2.80193	7.850799
-2.57109	6.610489
-0.36085	0.130216

(Vij- Vj+)	(Vij- Vj+)^2
-1.36429	1.861288
-0.14835	0.022006
-1.36429	1.861288
-1.8604	3.461074
-1.16001	1.345627
-0.43044	0.185283
-1.16001	1.345627
-1.05058	1.103711
-0.69309	0.480372
-1.78987	3.203639
-1.92606	3.709696
-0.81712	0.667677
0	0
-1.16001	1.345627
-1.98685	3.94759
-0.43044	0.185283
-1.05058	1.103711
-1.78987	3.203639
-0.43044	0.185283
-0.69309	0.480372
-1.36429	1.861288
-1.05058	1.103711

(Vij- Vj+)	(Vij- Vj+)^2
-3.28786	10.81003
-5.40512	29.21534
-5.30129	28.10372
-4.76994	22.75236
-5.25854	27.65227
-4.33224	18.76831
-5.48655	30.10228
-4.12866	17.04582
-5.43159	29.50214
-1.38233	1.910827
-2.24755	5.051496
-3.28786	10.81003
-4.76994	22.75236
-5.16082	26.63409
0	0
-4.91652	24.1722
-3.79275	14.38493
-5.10586	26.06976
-4.69055	22.00122
-4.76994	22.75236
-3.90879	15.27863
-5.43159	29.50214

Table.4.8 shows the sum and square of $(Vij- Vj+)^2$ -max point

Sum		SQRT
22.07669	d1+	4.698584
32.42611	d2+	5.694393
31.33027	d3+	5.597345
35.12525	d4+	5.926656
32.7089	d5+	5.719169
28.15605	d6+	5.306227
32.80363	d7+	5.727445
27.20493	d8+	5.215834
34.45711	d9+	5.870018
16.39319	d10+	4.04885
18.99584	d11+	4.358422
22.40349	d12+	4.733233
31.0825	d13+	5.575169
31.35663	d14+	5.599699
16.69941	d15+	4.086492
31.30818	d16+	5.595371
25.87051	d17+	5.086306
35.7778	d18+	5.981455
30.62672	d19+	5.534142
32.66603	d20+	5.71542
26.01332	d21+	5.100326
32.73733	d22+	5.721655

Table 4.8 shows the sum of four $(Vij- Vj+)^2$ that were in the table 4.7 and in the second column it is a square of sum column. This square is shown as di+ or Distance i from Ideal. In the next step negative ideal will be calculated.

Table.4.9. the forth step in TOPSIS method (it has five parts)-distance between min point and each point

(Vij- Vj+)	(Vij- Vj+)2
0.006276	3.94E-05
0	0
0	0
0.225931	0.051045
0.025103	0.00063
0	0
0.014121	0.000199
0.001569	2.46E-06
0.025103	0.00063
0	0
0.001569	2.46E-06
0	0
0	0
0.001569	2.46E-06
0.006276	3.94E-05
0.006276	3.94E-05
0.014121	0.000199
0.265155	0.070307
0.006276	3.94E-05
0.039224	0.001539
0.025103	0.00063
0.014121	0.000199

(Vij- Vj+)	(Vij- Vj+)2
0	0
0.193362	0.037389
0.773449	0.598224
1.515961	2.298138
0.278442	0.07753
0.06961	0.004846
0.37899	0.143634
0.278442	0.07753
0.773449	0.598224
0	0
0.123752	0.015315
0.007734	5.98E-05
0.06961	0.004846
0.123752	0.015315
0.007734	5.98E-05
0.06961	0.004846
0.06961	0.004846
0.935874	0.87586
0.030938	0.000957
0.278442	0.07753
0.030938	0.000957
0.123752	0.015315

(Vij- Vj+)	(Vij- Vj+)2
0.573122	0.328468
2.056339	4.22853
2.364126	5.589094
0.241454	0.0583
1.769778	3.132115
0.573122	0.328468
3.226462	10.41006
0.496175	0.246189
1.260337	1.588449
0.241454	0.0583
0.358201	0.128308
0.297174	0.088312
0.742935	0.551953
2.056339	4.22853
0	0
1.037456	1.076315
0.358201	0.128308
0.742935	0.551953
0.742935	0.551953
0.424534	0.18023
0.655375	0.429517
2.865608	8.211708

(Vij- Vj+)	(Vij- Vj+)2
0.622564	0.387586
1.838509	3.380116
0.622564	0.387586
0.126458	0.015992
0.826843	0.683669
1.55641	2.422411
0.826843	0.683669
0.936278	0.876616
1.293766	1.67383
0.196983	0.038802
0.060797	0.003696
1.169739	1.36829
1.986854	3.94759
0.826843	0.683669
0	0
1.55641	2.422411
0.936278	0.876616
0.196983	0.038802
1.55641	2.422411
1.293766	1.67383
0.622564	0.387586
0.936278	0.876616

(Vij- Vj+)	(Vij- Vj+)2
2.198694	4.834253
0.081433	0.006631
0.18526	0.034321
0.716611	0.513532
0.228013	0.05199
1.154314	1.332441
0	0
1.357897	1.843884
0.054967	0.003021
4.104228	16.84469
3.239001	10.49113
2.198694	4.834253
0.716611	0.513532
0.325732	0.106102
5.486555	30.10228
0.570032	0.324936
1.693808	2.868987
0.3807	0.144932
0.796009	0.63363
0.716611	0.513532
1.577766	2.489346
0.054967	0.003021

Table.4.10 shows the sum and square of $(Vij- Vj+)^2$ - min point

Sum		SQRT
5.550347	d1-	2.355917
7.652666	d2-	2.766345
6.609225	d3-	2.570841
2.937006	d4-	1.71377
3.945933	d5-	1.986437
4.088167	d6-	2.021921
11.23756	d7-	3.352247
3.044222	d8-	1.74477
3.864154	d9-	1.965745
16.94179	d10-	4.116041
10.63845	d11-	3.261664
6.290916	d12-	2.50817
5.017921	d13-	2.240072
5.033617	d14-	2.243572
30.10238	d15-	5.486564
3.828548	d16-	1.956668
3.878956	d17-	1.969506
1.681855	d18-	1.296863
3.608991	d19-	1.899734
2.446659	d20-	1.56418
3.308036	d21-	1.818801
9.10686	d22-	3.017757

Table 4.10 shows the sum of four $(Vij- Vj+)^2$ that were in the table 4.9 and in the second column it is a square of sum column. This square is shown as di- or Distance i from negative Ideal. In the next step sum of the di+ , di- will be calculated.

Table.4.11 shows di+ and di- and the sum of them

Distance i from positive ideal		Distance i from negative ideal		Sum
d1+	4.698584	d1-	2.355917	7.054502
d2+	5.694393	d2-	2.766345	8.460738
d3+	5.597345	d3-	2.570841	8.168186
d4+	5.926656	d4-	1.71377	7.640425
d5+	5.719169	d5-	1.986437	7.705607
d6+	5.306227	d6-	2.021921	7.328149
d7+	5.727445	d7-	3.352247	9.079692
d8+	5.215834	d8-	1.74477	6.960604
d9+	5.870018	d9-	1.965745	7.835763
d10+	4.04885	d10-	4.116041	8.16489
d11+	4.358422	d11-	3.261664	7.620085
d12+	4.733233	d12-	2.50817	7.241402
d13+	5.575169	d13-	2.240072	7.81524
d14+	5.599699	d14-	2.243572	7.843271
d15+	4.086492	d15-	5.486564	9.573056
d16+	5.595371	d16-	1.956668	7.552039
d17+	5.086306	d17-	1.969506	7.055812
d18+	5.981455	d18-	1.296863	7.278318
d19+	5.534142	d19-	1.899734	7.433876
d20+	5.71542	d20-	1.56418	7.2796
d21+	5.100326	d21-	1.818801	6.919127
d22+	5.721655	d22-	3.017757	8.739412

In the table 4.11, both di+ that stands for Distance i from positive ideal and di- that stands for Distance i from negative Ideal was shown differently. Now in the next and the last part of TOPSIS method distance between A_i and Ideal Solution, will be calculated in order to rank all the 22 parameters of website quality.

Fifth Step: Calculate distance between A_i and Ideal Solution

$$C_{li}+ = d_{i-}/(d_{i+}+d_{i-}) \quad (4.8)$$

$C_{li}+$ stands for the distance between A_i and Ideal Solution

Table.4.12 shows "cli+" that means distance between A_i and Ideal Solution

	cli+	**Sort cli+**	**Ranking**	**Question no.**
cl1+	0.333959	0.178182	22	18
cl2+	0.326963	0.214872	21	20
cl3+	0.314738	0.224303	20	4
cl4+	0.224303	0.250664	19	8
cl5+	0.257791	0.250868	18	9
cl6+	0.275912	0.255551	17	19
cl7+	0.369203	0.257791	16	5
cl8+	0.250664	0.259091	15	16
cl9+	0.250868	0.262866	14	21
cl10+	0.504115	0.275912	13	5
cl11+	0.428035	0.279132	12	17
cl12+	0.346365	0.286051	11	14
cl13+	0.286629	0.286629	**10**	**13**
cl14+	0.286051	0.314738	**9**	**3**
cl15+	0.573126	0.326963	**8**	**2**
cl16+	0.259091	0.333959	**7**	**1**
cl17+	0.279132	0.345304	**6**	**22**
cl18+	0.178182	0.346365	**5**	**12**
cl19+	0.255551	0.369203	**4**	**7**
cl20+	0.214872	0.428035	**3**	**11**
cl21+	0.262866	0.504115	**2**	**10**
cl22+	0.345304	0.573126	**1** →	**15**

Table 4.12 shows the last part of normal TOPSIS with about 22 affected parameters on website quality and also about 70 web user (n=70).It is completely obvious that question number 15,10,11,7,12,22,1,2 are the eight first important parameters on website quality. But as writer did this analysis, it is understood that normal numbers may have lots of uncertainties so if all the calculation process create with fuzzy numbers, it will make a super precise outcome and it is the first aim of this thesis.

In the next step, writer will explain the fuzzy TOPSIS using fuzzy trapezoid numbers that the trapezoid numbers came from average data of three experts and at the end the comparison between normal TOPSIS and also fuzzy TOPSIS will be illustrated.

4.3. Fuzzy TOPSIS

The approach is based on a fuzzy version of the "technique for order preference by similarity to ideal solution" (TOPSIS).The use of fuzzy logic theory allows one to avoid the intrinsic difficulty encountered in assessing "crisp" values in terms of the parameters. Using fuzzy trapezoid numbers enabled the writer to change normal TOPSIS into fuzzy TOPSIS which is more precisely as the result shows in the next paragraph.

The shape of fuzzy trapezoid numbers is:

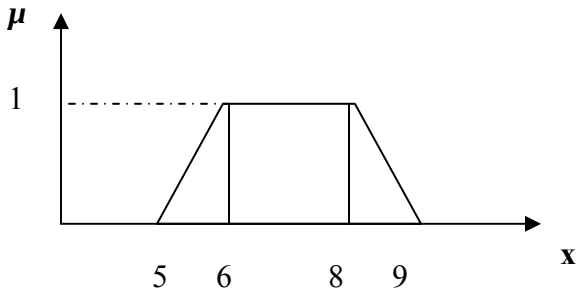


Fig.4.1. Fuzzy trapezoid number

Interviewing with the three experts and asking them to describe normal numbers into form of fuzzy numbers with interval leaded the writer to these kinds of trapezoid numbers that comes from the average numbers of experts and also whole process of fuzzy TOPSIS will be calculated upon these forms of numbers that are shown below:

The 1 number described as trapezoid number like (0.6, 0.8, 1.6, 1.8)
The 2 number described as trapezoid number like (1.4, 1.6, 2.5, 2.7)
The 3 number described as trapezoid number like (2.3, 2.5, 3.8, 4)
The 4 number described as trapezoid number like (3.6, 3.8, 4.6, 4.8)
The 5 number described as trapezoid number like (4.4, 4.6, 5.2, 5.4)

No matter if these fuzzy number have any overlap with each other. The reason that guide writer to do fuzzy TOPSIS with fuzzy numbers more than normal TOPSIS with normal numbers is just to have **meticulous attention** in the consequence.

In fuzzy TOPSIS method each part of normal TOPSIS will be reiterated just with the fuzzy trapezoid numbers.

Table 4.13 is one of the most important tables in this part because it is the fundamental of the fuzzy TOPSIS. All the results that came were given by web users through questionnaire (n=70), were introduced with fuzzy trapezoid numbers that were illustrated in the prior page.

In the first row, the fuzzy numbers description is shown then in the grey column the results of questionnaire is shown.

In the first step: each grey cell multiply by fuzzy trapezoid numbers in the first row and the results is shown in front of grey cell.

It is obvious that to multiply a normal number by fuzzy trapezoid number, the normal number should multiply on each elements of fuzzy trapezoid number.

Table.4.13 the result came from questionnaire with fuzzy numbers

R_{ij}	choice	Fuzzy number :1				choice	Fuzzy number :2				choice	Fuzzy number :3				choice	Fuzzy number :4				choice	Fuzzy number :5			
Q. No.	**1**	**0.6**	**0.8**	**1.6**	**1.8**	**2**	**1.4**	**1.6**	**2.5**	**2.7**	**3**	**2.3**	**2.5**	**3.8**	**4**	**4**	**3.6**	**3.8**	**4.6**	**4.8**	**5**	**4.4**	**4.6**	**5.2**	**5.4**
1	2	1.2	1.6	3.2	3.6	0	0	0	0	0	15	35	38	57	60	20	72	76	92	96	33	145	152	172	178
2	0	0	0	0	0	5	7	8	13	14	28	64	70	106	112	30	108	114	138	144	7	31	32	36	38
3	0	0	0	0	0	10	14	16	25	27	30	69	75	114	120	20	72	76	92	96	10	44	46	52	54
4	12	7.2	9.6	19	22	14	20	22	35	38	10	23	25	38	40	14	50	53	64	67	19	84	87	99	103
5	4	2.4	3.2	6.4	7.2	6	8.4	9.6	15	16	26	60	65	99	104	22	79	84	101	106	11	48	51	57	59
6	0	0	0	0	0	3	4.2	4.8	7.5	8.1	15	35	38	57	60	28	101	106	129	134	24	106	110	125	130
7	3	1.8	2.4	4.8	5.4	7	9.8	11	18	19	35	81	88	133	140	22	79	84	101	106	3	13	14	16	16
8	1	0.6	0.8	1.6	1.8	6	8.4	9.6	15	16	14	32	35	53	56	23	83	87	106	110	26	114	120	135	140
9	4	2.4	3.2	6.4	7.2	10	14	16	25	27	22	51	55	84	88	26	94	99	120	125	6	26	28	31	32
10	0	0	0	0	0	0	0	0	0	0	10	23	25	38	40	15	54	57	69	72	45	198	207	234	243
11	1	0.6	0.8	1.6	1.8	4	5.6	6.4	10	11	12	28	30	46	48	13	47	49	60	62	40	176	184	208	216
12	0	0	0	0	0	1	1.4	1.6	2.5	2.7	11	25	28	42	44	25	90	95	115	120	33	145	152	172	178
13	0	0	0	0	0	3	4.2	4.8	7.5	8.1	17	39	43	65	68	31	112	118	143	149	19	84	87	99	103
14	1	0.6	0.8	1.6	1.8	4	5.6	6.4	10	11	28	64	70	106	112	22	79	84	101	106	13	57	60	68	70
15	2	1.2	1.6	3.2	3.6	1	1.4	1.6	2.5	2.7	3	6.9	7.5	11	12	12	43	46	55	58	52	229	239	270	281
16	2	1.2	1.6	3.2	3.6	3	4.2	4.8	7.5	8.1	20	46	50	76	80	28	101	106	129	134	17	75	78	88	92
17	3	1.8	2.4	4.8	5.4	3	4.2	4.8	7.5	8.1	12	28	30	46	48	23	83	87	106	110	29	128	133	151	157
18	13	7.8	10	21	23	11	15	18	28	30	17	39	43	65	68	15	54	57	69	72	14	62	64	73	76
19	2	1.2	1.6	3.2	3.6	2	2.8	3.2	5	5.4	17	39	43	65	68	28	101	106	129	134	20	88	92	104	108
20	5	3	4	8	9	6	8.4	9.6	15	16	13	30	33	49	52	26	94	99	120	125	19	84	87	99	103
21	4	2.4	3.2	6.4	7.2	2	2.8	3.2	5	5.4	16	37	40	61	64	20	72	76	92	96	28	123	129	146	151
22	3	1.8	2.4	4.8	5.4	4	5.6	6.4	10	11	33	76	83	125	132	23	83	87	106	110	6	26	28	31	32

The first column in left in table 4.13 shows the 22 affective parameters in web quality and with fuzzy TOPSIS; they are going to rank with fuzzy trapezoid numbers.

As the Calculations between fuzzy Numbers are considered like this:

$D_1 = (a_1, b_1, c_1, d_1)$

$D_2 = (a_2, b_2, c_2, d_2)$

M= Fuzzy trapezoid number $= D_1 + D_2 = (a_1 + a_2, b1+b_2, c1+c_2, d1+d_2)$ (4.9)

Therefore table 4.14 discloses the sum of four trapezoid numbers that were existed in table 4.13. It is understood that the sum of fuzzy trapezoid numbers is like normal numbers.
Writer did all of this parts based upon the fuzzy TOPSIS method.

Table 4.14 the sum of fuzzy trapezoid numbers

Sum			
1	**2**	**3**	**4**
253	267	324	338
210	224	293	307
199	213	283	297
184	198	255	269
198	212	279	292
245	259	318	332
185	199	272	286
238	252	311	325
187	201	266	279
275	289	341	355
257	271	325	339
262	276	331	345
239	253	314	328
207	221	287	300
282	296	343	357
227	241	304	318
244	258	315	329
178	192	255	269
232	246	306	319
219	232	291	305
237	251	310	324
193	206	277	291

In the next part, each cell of table 4.14 divide by seventy (n=70) and then the division number of each cell will be place in the same cell in order to make the 22 fuzzy numbers that with this fuzzy numbers, the fuzzy TOPSIS can be started.

Table 4.15 the 22 fuzzy trapezoid numbers that should multiply by itself in the next step.

Table 4.15 the 22 fuzzy trapezoid numbers

R_{ij}= sum/n			
a_i	b_i	c_i	d_i
3.6	3.8	4.6	4.8
3	3.2	4.2	4.4
2.8	3	4	4.2
2.6	2.8	3.6	3.8
2.8	3	4	4.2
3.5	3.7	4.5	4.7
2.6	2.8	3.9	4.1
3.4	3.6	4.4	4.6
2.7	2.9	3.8	4
3.9	4.1	4.9	5.1
3.7	3.9	4.6	4.8
3.7	3.9	4.7	4.9
3.4	3.6	4.5	4.7
3	3.2	4.1	4.3
4	4.2	4.9	5.1
3.2	3.4	4.3	4.5
3.5	3.7	4.5	4.7
2.5	2.7	3.6	3.8
3.3	3.5	4.4	4.6
3.1	3.3	4.2	4.4
3.4	3.6	4.4	4.6
2.8	2.9	4	4.2

As it is obvious that the calculations between fuzzy Numbers are considered like this:

$D_1= (a_1, b_1, c_1, d_1)$

$D_2= (a_2, b_2, c_2, d_2)$

$M^{/}$= Not a Fuzzy trapezoid number= $D_1 * D_2$= (a (L_1, L_2), b, c, d (R_1, R_2)) **(4.10)**

$a=a_1*a_2$ $L_1= (b_1-a_1)* (b_2-a_2)$ (4.11)

$b=b_1*b_2$ $L_2=a_2* (b_1-a_1) +a_1* (b_2-a_2)$ (4.12)

$c=c_1*c_2$ $R_1= (d_1-c_1) * (d_2-c_2)$ (4.13)

$d=d_1*d_2$ $R_2= - [d_2* (d_1-c_1) +d_1* (d_2-c_2)]$ (4.14)

Therefore $\mu_M^{/}(x)$ are like table 4.16:

Table 4.16 the $\mu_M^{/}(x)$ for non -trapezoid fuzzy number

x	$\boldsymbol{\mu_M^{/}(x)}$
≤a	0
≥d	0
b≤x≤c	1
a≤x≤b	α € [0, 1]
c≤x≤d	α € [0, 1]

- If a≤x≤b & $x_1= [a_1, b_1]$, $x_2= [a_2, b_2]$ so that: $x_i = (b_i-a_i) \alpha +a_i$

  Then $x=x_1*x_2$ will be like: $x=L_1 \alpha^2 + L_2 \alpha + a;$ α € [0, 1] (4.15)

- If c≤x≤d

  Then $x=x_1*x_2$ will be like: $x=R_1 \alpha^2 + R_2 \alpha + d;$ α € [0, 1] (4.16)

In this way, by multiplying the table No.4.15 by itself, it means that the multiplying two fuzzy trapezoid numbers that will cause a non trapezoid number occurs.

$M^{/}$= Not a Fuzzy trapezoid number= $D_1*D_2= (a (L_1, L_2), b, c, d (R_1, R_2))$ (4.17)

By multiplying table 4.15 by itself, it makes Table 4.16 that displays 22 non trapezoid numbers that each one has about 8 elements and it is comprehensible that if :

$D_1= (a_1, b_1, c_1, d_1)$

$D_2= (a_2, b_2, c_2, d_2)$

$$M^{/} = \text{Not a Fuzzy trapezoid number} = D_1 * D_2 = (a\ (L_1, L_2), b, c, d\ (R_1, R_2)) \quad (4.18)$$

$$a = a_1 * a_2 \qquad L_1 = (b_1 - a_1)(b_2 - a_2) \quad (4.19)$$

$$b = b_1 * b_2 \qquad L_2 = a_2 (b_1 - a_1) + a_1 (b_2 - a_2) \quad (4.20)$$

$$c = c_1 * c_2 \qquad R_1 = (d_1 - c_1)(d_2 - c_2) \quad (4.21)$$

$$d = d_1 * d_2 \qquad R_2 = -[d_2 (d_1 - c_1) + d_1 (d_2 - c_2)] \quad (4.22)$$

Table 4.17 the 22 fuzzy non-trapezoid numbers

Question No. ↓	$(R_{ij})^2$							
	a	**L1**	**L2**	**b**	**c**	**d**	**R1**	**R2**
1	13.05	0.04	1.445	14.54	21.4	23.29	0.04	-1.93
2	9.017	0.04	1.201	10.26	17.56	19.27	0.04	-1.756
3	8.082	0.04	1.137	9.259	16.34	18	0.04	-1.697
4	6.894	0.039	1.035	7.969	13.31	14.79	0.039	-1.516
5	8.017	0.039	1.116	9.172	15.84	17.45	0.039	-1.647
6	12.26	0.04	1.401	13.7	20.65	22.51	0.04	-1.898
7	6.947	0.04	1.054	8.041	15.11	16.7	0.04	-1.635
8	11.6	0.04	1.362	13	19.71	21.53	0.04	-1.856
9	7.137	0.038	1.038	8.212	14.42	15.93	0.038	-1.551
10	15.43	0.04	1.571	17.05	23.73	25.72	0.04	-2.029
11	13.44	0.04	1.466	14.94	21.56	23.45	0.04	-1.937
12	14	0.04	1.497	15.53	22.35	24.28	0.04	-1.971
13	11.61	0.04	1.363	13.01	20.06	21.89	0.04	-1.871
14	8.745	0.038	1.149	9.932	16.79	18.42	0.038	-1.668
15	16.17	0.04	1.609	17.82	23.97	25.97	0.04	-2.038
16	10.52	0.04	1.297	11.85	18.85	20.62	0.04	-1.817
17	12.15	0.04	1.394	13.58	20.19	22.02	0.04	-1.877
18	6.459	0.04	1.017	7.515	13.24	14.73	0.04	-1.535
19	10.98	0.039	1.306	12.32	19.06	20.82	0.039	-1.799
20	9.743	0.039	1.231	11.01	17.26	18.93	0.039	-1.716
21	11.48	0.04	1.355	12.88	19.59	21.4	0.04	-1.85
22	7.563	0.039	1.084	8.686	15.68	17.28	0.039	-1.639
$\sum(R_{ij})^2 =$ **Sum**	**231.3**	**0.87**	**28.13**	**260.3**	**406.6**	**445**	**0.87**	**-39.23**
SQRT	**15.21**	**0.933**	**5.304**	**16.13**	**20.17**	**21.1**	**0.933**	**#NUM!**
1/sqrt	0.047			0.05	0.062	0.066		
	Trapezoid number			**=**	**0.047**	**0.05**	**0.062**	**0.066**

In the last row of table 4.17, after making sum and square of the table, one trapezoid number which is the (0.047, 0.05, 0.062, 0.066) will be transpired that is the number that writer will use it in the next levels of fuzzy TOPSIS.

Table 4.18 the 22 fuzzy processed trapezoid numbers

Question No. ↓	Trapezoid number n_{ij}			
	a	**b**	**c**	**d**
1	0.6188	0.721	1.326	1.531
2	0.4274	0.509	1.088	1.267
3	0.3831	0.459	1.013	1.184
4	0.3268	0.395	0.825	0.972
5	0.38	0.455	0.982	1.147
6	0.5812	0.679	1.28	1.48
7	0.3293	0.399	0.937	1.098
8	0.5498	0.645	1.222	1.416
9	0.3383	0.407	0.894	1.048
10	0.7316	0.845	1.471	1.691
11	0.637	0.741	1.336	1.542
12	0.6636	0.77	1.385	1.596
13	0.5503	0.645	1.243	1.439
14	0.4145	0.492	1.04	1.211
15	0.7666	0.884	1.486	1.707
16	0.4985	0.588	1.168	1.356
17	0.576	0.674	1.251	1.448
18	0.3062	0.373	0.821	0.969
19	0.5203	0.611	1.181	1.369
20	0.4619	0.546	1.07	1.245
21	0.5443	0.639	1.214	1.407
22	0.3585	0.431	0.972	1.136

Table 4.18 demonstrates that by multiplying each cell of table 4.17 by the trapezoid number (0.047, 0.05, 0.062, 0.066), the entire amount in table 4.18 occurs; for the first row it is like:

a= (13.05*0.047) =0.6188

b= (14.54*0.05) = 0.721

c= (21.4*0.062) = 1.326

d= (23.29*0.066) = 1.531

Then it will calculated for all the another 21 rows of the table 4.17 in order to make table 4.18.

As it was completely understood in the normal TOPSIS, maximum and minimum of each column calculated, but here because every row of the table 4.18 implicated on just one fuzzy trapezoid number, therefore writer tried to find which fuzzy number is maximum and which one is minimum. In order to this the space below of the curve of trapezoid numbers were calculated:

"Area of a trapezoid number "= S = 0.5 *h* [(d-a) + (b-c)] **(4.23)**

Then it is comprehend that the No.10 of these 22 parameters has the maximum area under the curve and No.4 has the minimum of the space under the curve.

Table.4.19. max and min of fuzzy trapezoid numbers, (A+ & A-)

A+	max Vi		no.10
0.731618	0.845261	1.470908	1.691156

A-	min Vi		no.4
0.326821	0.395156	0.825123	0.972472

Table 4.18 shows the maximum fuzzy number which is parameter number 10 that means Ideal (A+) and minimum fuzzy trapezoid number which is parameter number 4 that means negative Ideal (A-). In the next step the distance between Ideal and negative Ideal of each fuzzy trapezoid number will be calculated.

Table.4.20. distance between max point and each point (it has four parts).

a		b		c		d	
(Vij- Vj+)	(Vij- Vj+)2	(Vij- Vj+)	(Vij- Vj+)2	(Vij- Vj+)	(Vij- Vj+)2	(Vij- Vj+)	(Vij- Vj+)2
-0.11287	0.012739	-0.12433	0.015459	-0.14464	0.020921	-0.15991	0.02557
-0.30417	0.092519	-0.33656	0.11327	-0.38273	0.14648	-0.42394	0.179721
-0.34851	0.121457	-0.38611	0.149082	-0.45781	0.209594	-0.50746	0.257516
-0.4048	0.16386	-0.4501	0.202594	-0.64579	0.417039	-0.71868	0.516506
-0.35158	0.123609	-0.39041	0.152422	-0.48907	0.239191	-0.54384	0.295766
-0.15044	0.022634	-0.16585	0.027508	-0.19093	0.036452	-0.21115	0.044583
-0.4023	0.161847	-0.4465	0.199359	-0.53435	0.285532	-0.59275	0.351353
-0.18178	0.033045	-0.20054	0.040215	-0.249	0.062001	-0.2755	0.075898
-0.39332	0.154699	-0.43801	0.191857	-0.57722	0.333181	-0.64359	0.414213
0	0	0	0	0	0	0	0
-0.09463	0.008955	-0.10421	0.010859	-0.13479	0.018169	-0.14901	0.022203
-0.06804	0.00463	-0.07489	0.005609	-0.08584	0.007369	-0.09486	0.008998
-0.18132	0.032878	-0.20003	0.04001	-0.22768	0.051837	-0.25186	0.063434
-0.31708	0.100542	-0.35276	0.12444	-0.43042	0.185266	-0.4802	0.230596
0.034994	0.001225	0.03845	0.001478	0.014703	0.000216	0.016236	0.000264
-0.23311	0.054341	-0.25746	0.066286	-0.30265	0.091598	-0.335	0.112228
-0.15565	0.024227	-0.17161	0.02945	-0.21973	0.048283	-0.24306	0.059078
-0.42544	0.181001	-0.47257	0.223326	-0.6503	0.422893	-0.72229	0.521707
-0.21136	0.044672	-0.23431	0.054902	-0.28954	0.083836	-0.32218	0.103798
-0.26975	0.072763	-0.29913	0.089481	-0.4012	0.160961	-0.44611	0.199011
-0.18731	0.035083	-0.20665	0.042705	-0.25685	0.065972	-0.2842	0.080769
-0.37313	0.139222	-0.41454	0.171845	-0.49891	0.248916	-0.5548	0.307807

In table 4.20 at first (Vij- Vj+) that means the distance between the fuzzy number and the Idear number that is number 10 was calculated and in follow $(Vij- Vj+)^2$. The table 4.20 has four part that stands for (a, b, c, d) components of fuzzy trapezoid numbers.

Table.4.21. distance between max point and each point

di+			
a	**b**	**c**	**d**
0.012739	0.015459	0.020921	0.02557
0.092519	0.11327	0.14648	0.179721
0.121457	0.149082	0.209594	0.257516
0.16386	0.202594	0.417039	0.516506
0.123609	0.152422	0.239191	0.295766
0.022634	0.027508	0.036452	0.044583
0.161847	0.199359	0.285532	0.351353
0.033045	0.040215	0.062001	0.075898
0.154699	0.191857	0.333181	0.414213
0	0	0	0
0.008955	0.010859	0.018169	0.022203
0.00463	0.005609	0.007369	0.008998
0.032878	0.04001	0.051837	0.063434
0.100542	0.12444	0.185266	0.230596
0.001225	0.001478	0.000216	0.000264
0.054341	0.066286	0.091598	0.112228
0.024227	0.02945	0.048283	0.059078
0.181001	0.223326	0.422893	0.521707
0.044672	0.054902	0.083836	0.103798
0.072763	0.089481	0.160961	0.199011
0.035083	0.042705	0.065972	0.080769
0.139222	0.171845	0.248916	0.307807

Table 4.21 displays the 22 fuzzy trapezoid numbers that calculated by distance between max point and each point. The row 10 is calculated 0 because it was the max point and there is no distance for parameter number 10.

In follow it is obviously understand that table 4.22 shows the distance between negative ideal and each point (A-).

Table.4.22. distance between min point and each point (it has four parts).

a		b		c		d	
(Vij- Vj+)	**(Vij- Vj+)2**	**(Vij- Vj+)**	**(Vij- Vj+)2**	**(Vij- Vj+)**	**(Vij- Vj+)2**	**(Vij- Vj+)**	**(Vij- Vj+)2**
0.291931	0.085224	0.325772	0.106128	0.501143	0.251144	0.558778	0.312233
0.100628	0.010126	0.113549	0.012893	0.263058	0.069199	0.294748	0.086876
0.05629	0.003169	0.063993	0.004095	0.187971	0.035333	0.211223	0.044615
0	0	0	0	0	0	0	0
0.053216	0.002832	0.059692	0.003563	0.156713	0.024559	0.17484	0.030569
0.254352	0.064695	0.284251	0.080798	0.45486	0.206898	0.507538	0.257595
0.002494	6.22E-06	0.003608	1.3E-05	0.111433	0.012417	0.125933	0.015859
0.223013	0.049735	0.249568	0.062284	0.396786	0.157439	0.443188	0.196416
0.011479	0.000132	0.01209	0.000146	0.068567	0.004701	0.07509	0.005639
0.404797	0.16386	0.450105	0.202594	0.645785	0.417039	0.718684	0.516506
0.310168	0.096204	0.345899	0.119646	0.510991	0.261112	0.569677	0.324532
0.336754	0.113403	0.375212	0.140784	0.559943	0.313536	0.623824	0.389156
0.223474	0.049941	0.250079	0.062539	0.418108	0.174815	0.466822	0.217923
0.087712	0.007693	0.097344	0.009476	0.21536	0.04638	0.23848	0.056873
0.439791	0.193416	0.488554	0.238685	0.660488	0.436244	0.73492	0.540107
0.171685	0.029476	0.192643	0.037111	0.343134	0.117741	0.383679	0.147209
0.249147	0.062074	0.278494	0.077559	0.426052	0.181521	0.475625	0.226219
-0.02065	0.000426	-0.02247	0.000505	-0.00452	2.04E-05	-0.00361	1.3E-05
0.193439	0.037419	0.215793	0.046567	0.356241	0.126907	0.396507	0.157218
0.135051	0.018239	0.150971	0.022792	0.244586	0.059822	0.272578	0.074299
0.217491	0.047303	0.243452	0.059269	0.388936	0.151271	0.434484	0.188777
0.031672	0.001003	0.035562	0.001265	0.14687	0.021571	0.16388	0.026857

In table 4.22 at first (Vij- Vj+) that means the distance between the fuzzy number and the negative Ideal number that is number 4 was calculated and in follow $(Vij- Vj+)^2$. The table 4.22 has four part that stands for (a, b, c, d) components of fuzzy trapezoid numbers.

Table.4.23. distance between min point and each point.

di-			
a	**b**	**c**	**d**
0.085224	0.106128	0.251144	0.312233
0.010126	0.012893	0.069199	0.086876
0.003169	0.004095	0.035333	0.044615
0	0	0	0
0.002832	0.003563	0.024559	0.030569
0.064695	0.080798	0.206898	0.257595
6.22E-06	1.3E-05	0.012417	0.015859
0.049735	0.062284	0.157439	0.196416
0.000132	0.000146	0.004701	0.005639
0.16386	0.202594	0.417039	0.516506
0.096204	0.119646	0.261112	0.324532
0.113403	0.140784	0.313536	0.389156
0.049941	0.062539	0.174815	0.217923
0.007693	0.009476	0.04638	0.056873
0.193416	0.238685	0.436244	0.540107
0.029476	0.037111	0.117741	0.147209
0.062074	0.077559	0.181521	0.226219
0.000426	0.000505	2.04E-05	1.3E-05
0.037419	0.046567	0.126907	0.157218
0.018239	0.022792	0.059822	0.074299
0.047303	0.059269	0.151271	0.188777
0.001003	0.001265	0.021571	0.026857

Table 4.23 displays the 22 fuzzy trapezoid numbers that calculated by distance between min point and each point. The row 4 is calculated 0 because it was the min point and there is no distance for parameter number 4.

Table 4.24 indicates the sum of A+ (distance between point and ideal) and A-(distance between point and negative ideal).

Table.4.24 sum of A+ and A-

Sum			
a	**b**	**c**	**d**
0.097962	0.121586	0.272065	0.337803
0.102645	0.126163	0.21568	0.266598
0.124625	0.153177	0.244927	0.302132
0.16386	0.202594	0.417039	0.516506
0.126441	0.155985	0.26375	0.326335
0.087329	0.108306	0.24335	0.302177
0.161854	0.199372	0.297949	0.367212
0.08278	0.102499	0.21944	0.272314
0.154831	0.192003	0.337883	0.419851
0.16386	0.202594	0.417039	0.516506
0.105159	0.130505	0.279281	0.346735
0.118033	0.146393	0.320905	0.398154
0.082819	0.10255	0.226651	0.281357
0.108236	0.133916	0.231646	0.287469
0.194641	0.240164	0.43646	0.54037
0.083817	0.103398	0.209339	0.259438
0.086301	0.107009	0.229803	0.285297
0.181427	0.22383	0.422913	0.52172
0.082091	0.101469	0.210743	0.261016
0.091002	0.112273	0.220783	0.273309
0.082386	0.101974	0.217243	0.269546
0.140225	0.17311	0.270487	0.334664

The fuzzy method of TOPSIS is completely like the normal TOPSIS up to here but after calculating the sum based on this formal that Calculate distance between A_i and Ideal Solution:

$$C_{li}+ = d_{i-} /(d_{i+}+d_{i-}) \quad (4.24)$$

Now the sum of $(d_{i+}+d_{i-})$ was calculated but because all these numbers are fuzzy numbers not normal, so writer has to calculated the reverse sum in order to multiply it by the d_{i-} and finding the results, therefore in table 4.24 the reverse sum calculated according to this formula:

For making a fuzzy number reverse (a, b, c, d) will convert to: (1/d, 1/c, 1/b, 1/a) (4.25)

Table.4.25 reverse sum of A+ and A-

Reverse sum			
a	**b**	**c**	**d**
2.960304	3.675586	8.224623	10.208
3.750967	4.636503	7.92625	9.74235
3.309816	4.082849	6.528392	8.024052
1.936084	2.397859	4.935976	6.102754
3.064337	3.791463	6.410872	7.908838
3.309313	4.109306	9.233103	11.451
2.723221	3.356276	5.015738	6.178421
3.672237	4.557059	9.756184	12.08019
2.381795	2.959609	5.208247	6.458673
1.936084	2.397859	4.935976	6.102754
2.884048	3.580618	7.662542	9.509413
2.511589	3.116189	6.830925	8.47221
3.554201	4.412062	9.751367	12.07458
3.478641	4.316938	7.467358	9.239075
1.850582	2.291159	4.163826	5.137669
3.854488	4.776947	9.671385	11.93078
3.505122	4.351551	9.344998	11.58733
1.916736	2.364551	4.467669	5.511855
3.831187	4.745105	9.85527	12.18164
3.658859	4.529331	8.906835	10.98883
3.709942	4.603147	9.806405	12.13801
2.988073	3.697036	5.77667	7.131376

After calculated the table 4.25, it is time now to multiply these table with the table 4.23 or (di-) in order to do as equation (4.24).

It is understandable that if two fuzzy numbers multiply to each other the results is fuzzy but not trapezoid number. So 22 none trapezoid number will appear that are shown in the next page.

$$D_1 = (a_1, b_1, c_1, d_1)$$

$$D_2 = (a_2, b_2, c_2, d_2)$$

$$M^{/} = \text{Not a Fuzzy trapezoid number} = D_1 * D_2 = (a\,(L_1, L_2), b, c, d\,(R_1, R_2)) \quad (4.26)$$

$a = a_1 * a_2$ $\quad L_1 = (b_1 - a_1) * (b_2 - a_2)$ (4.27)

$b = b_1 * b_2$ $\quad L_2 = a_2 * (b_1 - a_1) + a_1 * (b_2 - a_2)$ (4.28)

$c = c_1 * c_2$ $\quad R_1 = (d_1 - c_1) * (d_2 - c_2)$ (4.29)

$d = d_1 * d_2$ $\quad R_2 = -[d_2 * (d_1 - c_1) + d_1 * (d_2 - c_2)]$ (4.30)

Table.4.26 22 fuzzy non trapezoid numbers

	cli+ a	L1	L2	b	c	d	R1	R2
1	0.252288	0.014952	0.122841	0.390081	2.065565	3.187279	0.121163	-1.24288
2	0.037982	0.002451	0.019347	0.05978	0.548491	0.846381	0.032103	-0.32999
3	0.010488	0.000716	0.005516	0.01672	0.230668	0.357995	0.013883	-0.14121
4	0	0	0	0	0	0	0	0
5	0.008678	0.000532	0.0043	0.01351	0.157445	0.241767	0.009003	-0.09332
6	0.214096	0.012883	0.105047	0.332025	1.910307	2.949721	0.112442	-1.15186
7	1.69E-05	4.3E-06	2.24E-05	4.37E-05	0.062283	0.097985	0.004002	-0.0397
8	0.182638	0.011104	0.09009	0.283832	1.536005	2.37274	0.090582	-0.92732
9	0.000314	8.32E-06	0.00011	0.000433	0.024486	0.036417	0.001172	-0.0131
10	0.317248	0.017886	0.150658	0.485792	2.058493	3.152112	0.116057	-1.20968
11	0.277458	0.016329	0.13462	0.428407	2.000782	3.086108	0.117128	-1.20245
12	0.284822	0.016555	0.137334	0.43871	2.14174	3.29701	0.124114	-1.27938
13	0.177499	0.010808	0.08762	0.275927	1.704681	2.631328	0.10015	-1.0268
14	0.026763	0.001494	0.012649	0.040906	0.346337	0.52545	0.01859	-0.1977
15	0.357933	0.019945	0.168989	0.546866	1.816445	2.77489	0.101146	-1.05959
16	0.113614	0.007043	0.056621	0.177279	1.138716	1.756324	0.066582	-0.68419
17	0.217578	0.013107	0.106817	0.337502	1.696309	2.621278	0.10023	-1.0252
18	0.000817	3.52E-05	0.000342	0.001194	9.11E-05	7.18E-05	-7.7E-06	2.71E-05
19	0.143358	0.008361	0.069246	0.220964	1.250706	1.91517	0.070513	-0.73498
20	0.066733	0.003963	0.032536	0.103233	0.532828	0.816456	0.03014	-0.31377
21	0.17549	0.010688	0.086645	0.272823	1.483424	2.291373	0.087449	-0.8954
22	0.002997	0.000185	0.001493	0.004676	0.124608	0.191525	0.007161	-0.07408

Because in table 4.26, about 22 non trapezoid numbers calculated, using equation number (4.26), (4.27), (4.28), (4.29), (4.30):

Each of these 22 numbers makes a curve so it had better to calculate the area under each curve in order to estimate the ranking numbers so the next step is to draw each curve and calculate the area under the curve.

Table.4.27 indicates ranking schedule of 22 parameters

Area	Ranking	Question no.
0	22	4
0.002219	21	21
0.055007	20	20
0.098024	19	9
0.104947	18	8
0.107445	17	17
0.145594	16	10
0.159111	15	1
0.170726	14	14
0.199815	13	5
0.208055	12	12
0.225176	11	6
0.234297	10	19
0.257087	9	7
0.312317	8	11
0.328953	7	18
0.33195	6	13
0.344303	5	15
0.35219	4	3
0.352995	3	22
0.375668	2	16
0.446369	1	2

Table 4.27 demonstrated the area under the curve of each non trapezoid numbers in the first left column. In the middle column the ranking is calculated and in the right the question numbers is shown. As it is obvious first rank goes to the question number 2 with the area under the curve 0.446369, and the second rank is for question number 16 with the 0.375668 area under the curve and also third rank is for question number 22 with the area under the curve about 0.352995, in follow the forth rank is for question number 3 with the 0.32219 area under the curve and also fifth rank for question number 15 with the 0.344303 area under the curve and sixth rank for question number 13 with the 0.33195 area under the curve and seventh rank for question number 18 with the 0.328953 area under the curve and the last one that has a eighth rank is question number 11 with approximately 0.312317 area under the curve.

4.4. Comparing TOPSIS with Fuzzy TOPSIS

After doing the TOPSIS method with normal numbers and accordingly fuzzy TOPSIS with fuzzy numbers, it's a time to make a comparison between the results of the methods.

Table 4.28 comparing the result of normal TOPSIS and fuzzy TOPSIS

Question No. ranked by TOPSIS	**Rank**	**Question No. ranked by Fuzzy TOPSIS**	
18	22	4	
20	21	21	
4	20	20	
8	19	9	
9	18	8	
19	17	17	
5	16	10	
16	15	1	
21	14	14	
5	13	5	
17	12	12	
14	11	6	
13	10	19	
3	9	7	√
2	8	11	√
1	7	18	
22	6	13	√
12	5	15	√
7	4	3	√
11	3	22	√
10	2	16	
15	1	2	√

In the upside table, results of both normal TOPSIS with normal numbers and fuzzy TOPSIS with fuzzy numbers compare with each others. In the left column there are criteria that ranked by TOPSIS and in the right column there are criteria that has been ranked by fuzzy TOPSIS and ticks shows the parameters the repeated in both fuzzy and normal methods in first ten top rank.

In the table, from first ten important parameters, seven of them were repeated both in TOPSIS and fuzzy TOPSIS and it means that the consequence of these both methods are close to each other (approximately the results are the same) but in the fuzzy TOPSIS because of fuzzy numbers

that are more precise than normal numbers, it seems that the results is more strict than the results with normal numbers.

After comparing the results of both normal and fuzzy TOPSIS methods and ranked the parameters and clarified eight of most important criteria, it is time to choose them and make a pairwise matrix in order to interview with experts and starting AHP.

The pairwise matrix that is shown in the below is the matrix that fill out by eight experts with fuzzy numbers. Experts compared parameters two by two with each other and answered with fuzzy trapezoid numbers in this matrix.

Table 4.29 A sample of pairwise matrix that asked just expert to fill it

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	1							
2		1						
3			1					
4				1				
5					1			
6						1		
7							1	
8								1

In the upside matrix number 1 stands for coherence and complexity, number 2 stands for responsiveness, no. 3 stands for comparative performance, no. 4 stands for legibility , no. 5 stands for reliability, no. 6 stands for technical efficiency & usefulness, no. 7 stands for customer expectation & satisfaction and no. 8 stands for security.

As it is clear and in accordance with the fuzzy AHP method, it is only necessary to fill half part of the matrix and another part will be the vice- versa while the diameter units will be number 1.

4.5. Fuzzy AHP

World around us is full of multi criteria decision making problems that everybody may interface with them during a day, an example of one of them is buying a house. Important criteria that are mentioned are: cost of house, culture of people who live in that region, easy access to the malls or our job, access to the educational centers for children and at last related expenditure. Now this question shall be considered that “if there are three different options for buying a house, which one will be the best decision to buy?”

In multi criteria decision making problems that will mentioned later, there are just quantitative criteria that will be mentioned therefore for each problem there are limited criteria.

Many practical optimization problems are characterized by some flexibility in the problem constraints, where this flexibility can be exploited for additional trade-off between improving the objective function and satisfying the constraints. Especially in decision making, this type of flexibility could lead to workable solutions, where the goals and the constraints specified by different parties involved in the decision making are traded off against one another and satisfied to various degrees. Fuzzy sets have proven to be a suitable representation for modeling this type of soft constraints. Conventionally, the fuzzy optimization problem in such a setting is defined as the simultaneous satisfaction of the constraints and the goals. No additional distinction is assumed to exist amongst the constraints and the goals.

Many problems in decision making structure reality into constituent parts, that is, into hierarchical charts in which the goal is at the top, while the decisions are at the lowest level of the chart. At the intermediate levels of the chart are the various attributes and/or conditions which must be considered in order to arrive at a decision. A rather simplified hierarchal chart is given, in which the goal, all attributes and all possible decision occupy boxes in the hierarchal structure. The main idea in the analytical hierarchal process (AHP) approach is to construct a pairwise ranking of the boxes at any given level relative to the boxes at the next highest level to which they are connected. These pairwise rankings are used to constructed priorities which are then combined to create and overall priority for each course of action under considerations. The course of action with the highest priority is then chosen. Uncertainly in the assigning of priorities and the use of semantic variables in their assignment lead naturally to the inclusion of fuzzy logic into the structure of the AHP paradigm.

Analytical hierarchy process (AHP) is one of the most famous methods for solving multi criteria problems that was mentioned first by T.L.Saaty. He started to use Fuzzy AHP to make AHP more realistic and to take results more precisely.

Criteria in this method could be both quantitative and qualitative. There are about four steps in fuzzy AHP that were illustrated below:

4.5.1. Using Buckley Method

In this method, Trapezoid fuzzy number is a kind of number that we use.

For example: D_1= (5, 6, 8, 9) is like fig No.4.1

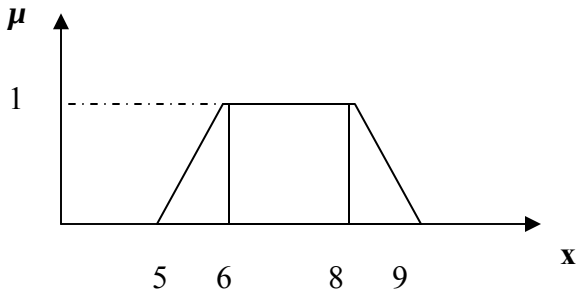


Fig.4.1. Fuzzy trapezoid number

All the equations of fuzzy AHP will be illustrated as follows;

$$\text{Average} = z_i = \{ \prod^{n}_{j=1} a_{ij} \}^{1/n} \quad (4.31)$$

Calculations between fuzzy Numbers are considered like this:

$D_1 = (a_1, b_1, c_1, d_1)$

$D_2 = (a_2, b_2, c_2, d_2)$

M= Fuzzy trapezoid number $= D_1 + D_2 = (a_1 + a_2, b1+b_2, c1+c_2, d1+d_2)$ (4.32)

$M^{/}$= Not a Fuzzy trapezoid number= $D_1 * D_2 = (a\ (L_1, L_2), b, c, d\ (R_1, R_2))$ (4.33)

$a = a_1 * a_2$ $\quad L_1 = (b_1 - a_1) * (b_2 - a_2)$ (4.34)

$b = b_1 * b_2$ $\quad L_2 = a_2 * (b_1 - a_1) + a_1 * (b_2 - a_2)$ (4.35)

$c = c_1 * c_2$ $\quad R_1 = (d_1 - c_1) * (d_2 - c_2)$ (4.36)

$d = d_1 * d_2$ $\quad R_2 = -[d_2 * (d_1 - c_1) + d_1 * (d_2 - c_2)]$ (4.37)

Therefore $\mu_M^{/}(x)$ are like this:

Table 4.30 the $\mu_M^{/}(x)$ for non -trapezoid fuzzy number

x	$\boldsymbol{\mu_M^{/}(x)}$
≤a	0
≥d	0
b≤x≤c	1
a≤x≤b	α € [0, 1]
c≤x≤d	α € [0, 1]

b.1) If a≤x≤b & $x_1= [a_1, b_1]$, $x_2= [a_2, b_2]$ so that: $x_i = (b_i-a_i)\ \alpha + a_i$

Then $x=x_1*x_2$ will be like this form: $x=L_1\ \alpha^2 + L_2\ \alpha + a;\ \alpha \in [0, 1]$ (4.38)

b.2) If c≤x≤d

Then $x=x_1*x_2$ will be like this form: $x=R_1\ \alpha^2 + R_2\ \alpha + d;\ \alpha \in [0, 1]$ (4.39)

c) The sum of fuzzy numbers like this:

$$[a_i\ (L_{i1}, L_{i2}), b_i, c_i, d_i\ (R_{i1}, R_{i2})] \quad (4.40)$$

Is this form:

Suppose two fuzzy numbers like this:

$M^{/}_1 = [a_1\ (L_{11}, L_{12}), b_1, c_1, d_1\ (R_{11}, R_{12})]$

$M^{/}_2 = [a_2\ (L_{21}, L_{22}), b_2, c_2, d_2\ (R_{21}, R_{22})]$

Therefore:

$$M'_1 + M'_2 = M'' = \{(a_1+a_2)\ [L_{11}+L_{21},\ L_{12}+L_{22}],\ (b_1+b_2),\ (c_1+c_2),\ (d_1+d_2)\ [R_{11}+R_{21},\ R_{12}+R_{22}]\} \quad (4.41)$$

& $\mu_M''(x)$ is:

Table 4.31the $\mu_M''(x)$ for sum of two non -trapezoid fuzzy number

x	$\boldsymbol{\mu_M''(x)}$
$\leq(a_1+a_2)$	0
$\geq(d_1+d_2)$	0
$(b_1+b_2) \leq x \leq (c_1+c_2)$	1
$(a_1+a_2) \leq x \leq (b_1+b_2)$	$\alpha \in [0, 1]$
$(c_1+c_2) \leq x \leq (d_1+d_2)$	$\alpha \in [0, 1]$

c.1) If $(a_1+a_2) \leq x \leq (b_1+b_2)$ and it is understand from b.1. Point that $x=L_{i1}\ \alpha^2 + L_{i2}\ \alpha + a_i$

Therefore $x=x_1+x_2$ is like this form:

$$X= (L_{11}+L_{21})\ \alpha^2 + (L_{12}+L_{22})\ \alpha + (a_1+a_2) \quad (4.42)$$

c.2) If $(c_1+c_2) \leq x \leq (d_1+d_2)$

Therefore $x=x_1+x_2$ is like this form:

$$X= (R_{11}+R_{21})\ \alpha^2 + (R_{12}+R_{22})\ \alpha + (d_1+d_2) \quad (4.43)$$

4.5.3.2. Algorithm

First Step:

Find the pairwise matrix (A) form decision makers like this form: $a_{ij}= (a_{ij}, b_{ij}, c_{ij}, d_{ij})$

Table 4.32 pairwise matrix (both part)

	1				2				3				4			
1	1	1	1	1	2.95	3.29	3.85	4.17	3.14	3.51	4.07	4.41	1.43	1.89	2.35	2.68
2	0.24	0.26	0.3	0.34	1	1	1	1	2.52	2.93	3.34	3.67	1.46	1.72	2.11	2.44
3	0.23	0.25	0.28	0.32	0.27	0.3	0.34	0.4	1	1	1	1	1.1	1.45	1.99	2.3
4	0.37	0.43	0.53	0.7	0.41	0.47	0.58	0.68	0.43	0.5	0.69	0.91	1	1	1	1
5	0.5	0.58	0.75	0.9	0.52	0.59	0.77	0.91	0.49	0.55	0.77	1.03	0.35	0.4	0.5	0.57
6	0.37	0.43	0.52	0.66	0.47	0.55	0.73	1	0.41	0.46	0.65	0.77	0.34	0.38	0.49	0.57
7	0.4	0.45	0.6	0.71	0.53	0.61	0.84	1.05	0.45	0.5	0.68	0.82	0.29	0.33	0.39	0.46
8	0.52	0.64	0.83	1.19	0.57	0.68	0.91	1.19	0.65	0.76	1.02	1.38	0.42	0.47	0.65	0.77

5				6				7				8			
1.11	1.33	1.73	2.02	1.52	1.93	2.34	2.72	1.41	1.67	2.23	2.51	0.84	1.2	1.56	1.91
1.1	1.31	1.69	1.94	1	1.37	1.83	2.11	0.96	1.19	1.64	1.89	0.84	1.09	1.47	1.76
0.98	1.29	1.81	2.05	1.3	1.55	2.16	2.45	1.22	1.48	2	2.24	0.73	0.98	1.32	1.55
1.77	2.02	2.51	2.84	1.77	2.03	2.62	2.91	2.16	2.59	3.03	3.41	1.31	1.54	2.11	2.37
1	1	1	1	2.41	2.84	3.28	3.6	2	2.44	2.88	3.25	1.78	2.06	2.59	2.88
0.28	0.3	0.35	0.42	1	1	1	1	2.33	2.61	3.21	3.54	1.49	1.68	2.21	2.46
0.31	0.35	0.41	0.5	0.28	0.31	0.38	0.43	1	1	1	1	1.98	2.34	2.84	3.21
0.35	0.39	0.49	0.56	0.41	0.45	0.59	0.67	0.31	0.35	0.43	0.5	1	1	1	1

Table 4.32 displays the 8*8 matrix which is completely fill out by eight experts in a way that they compared parameters two by two with each other and answered with fuzzy trapezoid numbers in this matrix also in the table the average of expert's ideas is shown.

Accordingly numbers 1 to 8 show: number 1 stands for coherence and complexity, number 2 stands for responsiveness, no. 3 stands for comparative performance, no. 4 stands for legibility , no. 5 stands for reliability, no. 6 stands for technical efficiency & usefulness, no. 7 stands for customer expectation & satisfaction and no. 8 stands for security.

Second Step:

Calculate w_i weight (geometrical average from each row of the A) like this:

$$Zi= \{a_{i1}(0)\ a_{i2}(0)\ldots(0)a_{in}\}^{1/n} \ :\ \forall i \qquad \text{then} \longrightarrow \qquad wi = zi(:)(z_1 (+)z_2(+)\ldots.(+)\ z_n) \tag{4.44}$$

Details of the w_i calculation are as below:

Right & left of fuzzy a_{ij} (in the crisp line L) were defined in this formula:

$$f_i(\alpha) = [\prod^{n}_{j=1} (b_{ij}- a_{ij})\ \alpha + a_{ij}]^{1/n} \quad ; \quad \alpha \in [0, 1] \tag{4.45}$$

$$g_i(\alpha) = [\prod^{n}_{j=1} (d_{ij}- c_{ij})\ \alpha + c_{ij}]^{1/n} \quad ; \quad \alpha \in [0, 1] \tag{4.46}$$

Also:

$$ai = \{\prod^{n}_{j=1} a_{ij}^{1/n}\} \quad ; \quad a = \sum^{m}_{i=1} ai \tag{4.47}$$

$$bi = \{\prod^{n}_{j=1} b_{ij}^{1/n}\} \quad ; \quad b = \sum^{m}_{i=1} bi \tag{4.48}$$

$$ci = \{\prod^{n}_{j=1} c_{ij}^{1/n}\} \quad ; \quad c = \sum^{m}_{i=1} ci \tag{4.49}$$

$$di = \{\prod^{n}_{j=1} d_{ij}^{1/n}\} \quad ; \quad d = \sum^{m}_{i=1} di \tag{4.50}$$

Table 4.33 the calculation of $a_i\ b_i\ c_i\ d_i$ (first part)

$\mathbf{a_i}$	$\mathbf{b_i}$	$\mathbf{c_i}$	$\mathbf{d_i}$
26.46225	112.0075	519.3609	1296.479
0.784247	3.051571	15.96811	41.2656
0.076101	0.309913	1.9908	5.073654
0.586204	1.662095	8.938292	29.08819
0.375947	1.072446	5.411598	16.06385
0.023555	0.05522	0.299952	1.03849
0.004731	0.011455	0.058462	0.193734
0.003576	0.009656	0.061915	0.282545

Table 4.33 demonstrated how to find out of $a_i\, b_i\, c_i\, d_i$ from the8*8 matrix based upon the table 4.32 and also upside formula.

In part two of this table shows that all the numbers in first part of table 4.33 should have 8^{th} square (or power in 1/8) because the matrix was 8*8 so 8 elements in each rows and columns.

Table 4.34. the calculation of $a_i\, b_i\, c_i\, d_i$ (second part)

$\mathbf{a_i}$	$\mathbf{b_i}$	$\mathbf{c_i}$	$\mathbf{d_i}$
1.506012	1.803665	2.184911	2.449603
0.970078	1.149649	1.413861	1.59202
0.724726	0.863784	1.089879	1.225082
0.935419	1.06557	1.314943	1.523928
0.884893	1.008781	1.234996	1.414918
0.625907	0.696246	0.860264	1.004732
0.512111	0.571973	0.701229	0.814518
0.494514	0.559887	0.706276	0.853858

Table 4.35 another form of $a_i\, b_i\, c_i\, d_i$

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**		
ai	1.506012	0.970078	0.724726	0.935419	0.884893	0.625907	0.512111	0.494514	**a=∑ai**	6.653659
bi	1.803665	1.149649	0.863784	1.06557	1.008781	0.696246	0.571973	0.559887	**b=∑bi**	7.719554
ci	2.184911	1.413861	1.089879	1.314943	1.234996	0.860264	0.701229	0.706276	**c=∑ci**	9.506358
di	2.449603	1.59202	1.225082	1.523928	1.414918	1.004732	0.814518	0.853858	**d=∑di**	10.87866

Table 4.34 displays the rotated form of table 4.33 and at the right column a, b, c and d are calculated with the form of:

$$a=\sum ai = 6.653659$$
$$b=\sum bi = 7.719554$$
$$c=\sum ci = 9.506358$$
$$d=\sum di = 10.87866$$

Therefore: weight of w_i is like this: $w_i= (a_i/d , b_i/c , c_i/b , d_i/a)$; $\forall i$

Table 4.36 the w_i

W_i	a_i	b_i	c_i	d_i
w1	0.138437	0.189732	0.283036	0.368159
w2	0.089173	0.120935	0.183153	0.23927
w3	0.066619	0.090864	0.141184	0.184122
w4	0.085987	0.11209	0.170339	0.229036
w5	0.081342	0.106116	0.159983	0.212653
w6	0.057535	0.07324	0.11144	0.151004
w7	0.047075	0.060167	0.090838	0.122417
w8	0.045457	0.058896	0.091492	0.128329

In table 4.36 w_i base upon the formula was calculated for each of a_i , b_i, c_i, d_i

Then $\mu\ w_i\ (x)$ defined as:

Table4.37 the $\mu\ w_i\ (x)$ for w_i (weight)

x	$\mu\ w_i\ (x)$
$\leq(a_i/d)$	0
$\geq(\ d_i/a)$	0
$[b_i/c\ ,\ c_i/b]$	1
$[a_i/d\ ,\ b_i/c]$	$\alpha \in [0, 1]$
$[c_i/b\ ,\ d_i/a]$	$\alpha \in [0, 1]$

If $x \in [a_i/d, b_i/c]$ therefore $x = f_i\ (\alpha) / g_i\ (\alpha)$ so $f\ (\alpha) = \sum^{m}_{i=1} f_i\ (\alpha)$

If $x \in [c_i/b, d_i/a]$ therefore $x = g_i\ (\alpha) / f_i\ (\alpha)$ so $g\ (\alpha) = \sum^{m}_{i=1} g_i\ (\alpha)$

In the last part of the calculation the area under the curve will be calculated in order to find the weight of the eight parameters.

Table 4.38 the area under the curve

Criteria	Area
Coherence, Complexity	0.323025
Responsiveness	0.212316
Legibility	0.167823
Reliability	0.201299
Comparative Performance	0.185177
Technical Efficiency & Usefulness	0.131669
Security	0.106012
Customer Expectation & Satisfaction	0.115468

As it is shown in table 4.38, the amount of "S" or the area under the curve of non trapezoid numbers are calculated in the left column and in the right they arranged based on the rank. It is plainly; understand from the table that the first rank goes to coherence that refers to the degree to which the environmental landscape hangs together, easy to understand & clear and also complexity (richness of the elements in a setting) with the weight of 0.323025. The second rank is Responsiveness that means to be able to response to customer needs, with the weight of 0.212316.the third rank is Legibility that means Distinctiveness, by possessing a memorable component, a landmark, and a scene facilitates finding one's way, with the weight 0.167823. In follows reliability with weight of 0.201299 that means ability to perform the promised service dependably and accurately and then comparative performance with the weight of 0.185177 that also means pay attention to performance of competitors then rank six belongs to technical efficiency & usefulness with the weight of 0.131669 that means do the right things and accordingly security (quality or state of being secure) with the weight of 0.106012 and finally customer expectation & satisfaction that means whatever customers really want with the exact weight of 0.115468.

4.6. Conclusion

The results of ranking parameters with fuzzy AHP is shown in table 4.93 and it is obvious that the first rank goes to coherence (refers to the degree to which the environmental landscape hangs together, easy to understand & clear) and also complexity (richness of the elements in a setting) with the weight of 0.323025. The second rank is Responsiveness that means to be able to response to customer needs, with the weight of 0.212316.The third rank is reliability with weight of 0.201299 that means ability to perform the promised service dependably and accurately and then comparative performance with the weight of 0.185177 that also means pay attention to performance of competitors, fifth rank goes to Legibility that means Distinctiveness, by possessing a memorable component, a landmark, and a scene facilitates finding one's way, with the weight 0.167823. In follows rank six belongs to technical efficiency & usefulness with the weight of 0.131669 that means do the right things and accordingly customer expectation & satisfaction that means whatever customers really want with the exact weight of 0.115468 and finally security (quality or state of being secured) with the weight of 0.106012.

Table 4.39 eight of most important parameters that affect on website quality ranked by their weight

Parameters	weight	Rank
Coherence, Complexity	0.323025	1
Responsiveness	0.212316	2
Reliability	0.201299	3
Comparative Performance	0.185177	4
Legibility	0.167823	5
Technical Efficiency & Usefulness	0.131669	6
Customer Expectation & Satisfaction	0.115468	7
Security	0.106012	8

Chapter 5
Conclusion

The web is growing at a dramatic place and is significantly impacting customer and business market behaviors. As a result, most firms have started developing marketing strategies for the web. Although web is fundamentally changing, and will continue to change, marketing thought and practice. The web-based markets of tomorrow may have little resemblance to the markets of today. So it is really important to upgrade our knowledge about market, customer and web based marketing. To fide out how to increase our we based marketing, it is better to understand complete meaning of website quality, the factors that affect it entirely and attempt to reserve higher position in e-commerce for our company.

The best idea to improve the electronic commerce in Iran is to find out how to make commercial website attractive enough to attract customers? This attraction won't be appearing unless working on website quality and try to increase it as much as possible and at the stage of world standard. It is obvious to companies investigating to understand how to increase their number of visitors through the web. High website quality causes high number of visitors in web and this aim is one of the by product conclusion of this thesis.

In this research the problem is to identify parameters of website quality of B2C commercial websites in Iran. The case study is a B2C commercial website that interacts with customers and it is an electronic-bookshop. Some electronic bookstore like amazon.com that sells books through all over the world is a good example of B2C websites. Although there are just a few electronic

bookstores in Iran but it is really essential to find out some characteristics of B2C websites quality which can cause improving in e- commerce in Iran.

This thesis makes two significant innovations, the first one is to analyze that "how we can adjust related parameters of website quality to the condition of Iran", in order this purpose, writer survey on a sample of Iranian web user with Iranian commercial website and the second innovation is to fin out affective parameters on e-bookstore as a kind of B2C websites that directly work with e-customers.

After gathering information through the literature Review, the taxonomy was prepared that shows as many as parameters that affect on website quality. Then in the second step, based on the taxonomy first questionnaire was adjusted just to gather information from web users. In the third step, all the gathered data processed and ranked with the Technique for order preference by similarity to ideal solution (TOPSIS).

Table.5.1 shows "cli+" that means distance between A_i and Ideal Solution

	cli+	**sort cli+**	**Ranking**	**Question No.**
cl1+	0.333959	0.178182	22	18
cl2+	0.326963	0.214872	21	20
cl3+	0.314738	0.224303	20	4
cl4+	0.224303	0.250664	19	8
cl5+	0.257791	0.250868	18	9
cl6+	0.275912	0.255551	17	19
cl7+	0.369203	0.257791	16	5
cl8+	0.250664	0.259091	15	16
cl9+	0.250868	0.262866	14	21
cl10+	0.504115	0.275912	13	5
cl11+	0.428035	0.279132	12	17
cl12+	0.346365	0.286051	11	14
cl13+	0.286629	0.286629	**10**	**13**
cl14+	0.286051	0.314738	**9**	**3**
cl15+	0.573126	0.326963	**8**	**2**
cl16+	0.259091	0.333959	**7**	**1**
cl17+	0.279132	0.345304	**6**	**22**
cl18+	0.178182	0.346365	**5**	**12**
cl19+	0.255551	0.369203	**4**	**7**
cl20+	0.214872	0.428035	**3**	**11**
cl21+	0.262866	0.504115	**2**	**10**
cl22+	0.345304	0.573126	**1** →	**15**

Table 5.1 shows the last part of normal TOPSIS with about 22 affected parameters on website quality and also about 70 web user (n=70).It is completely obvious that question number

15,10,11,7,12,22,1,2 are the eight first important parameters on website quality. But as writer did this analysis, it is understood that normal numbers may have lots of uncertainties so if all the calculation process create with fuzzy numbers, it will make a super precise outcome and it is the first aim of this thesis.

In the next step, writer will explain the fuzzy TOPSIS using fuzzy trapezoid numbers that the trapezoid numbers came from average data of three experts and at the end the comparison between normal TOPSIS and also fuzzy TOPSIS will be illustrated.

Accordingly in fourth step with the using of fuzzy numbers especially fuzzy trapezoid numbers it processed with fuzzy TOPSIS.

Accordingly the results of both fuzzy TOPSIS and TOPSIS compared with each other.

Table 5.2 comparing the result of normal TOPSIS and fuzzy TOPSIS

Question No. ranked by TOPSIS	**Rank**	**Question No. ranked by Fuzzy TOPSIS**	
18	22	4	
20	21	21	
4	20	20	
8	19	9	
9	18	8	
19	17	17	
5	16	10	
16	15	1	
21	14	14	
5	13	5	
17	12	12	
14	11	6	
13	10	19	
3	9	7	√
2	8	11	√
1	7	18	
22	6	13	√
12	5	15	√
7	4	3	√
11	3	22	√
10	2	16	
15	1	2	√

In the upside table, results of both normal TOPSIS with normal numbers and fuzzy TOPSIS with fuzzy numbers compare with each others. In the left column there are criteria that ranked by TOPSIS and in the right column there are criteria that has been ranked by fuzzy TOPSIS and ticks shows the parameters the repeated in both fuzzy and normal methods in first ten top rank.
In the table, from first ten important parameters, seven of them were repeated both in TOPSIS and fuzzy TOPSIS and it means that the consequence of these both methods are close to each other (approximately the results are the same) but in the fuzzy TOPSIS because of fuzzy numbers that are more precise than normal numbers, it seems that the results is more strict than the results with normal numbers.
After comparing the results of both normal and fuzzy TOPSIS methods and ranked the parameters and clarified eight of most important criteria, it is time to choose them and make a pairwise matrix in order to interview with experts and starting AHP.

Finally eight criteria which were the most important ones from fuzzy TOPSIS has obtained, second questionnaire adjusted just for experts that was a pairwise matrix, then using the matrix data, all analyzed with the fuzzy analytical hieratical process (AHP). At the end weight of eight selected factor was calculated by AHP that is shown in the below tables:

Table 5.3 eight of most important parameters that affect on website quality

Parameters	**weight**	**Rank**
Coherence, Complexity	0.323025	1
Responsiveness	0.212316	2
Reliability	0.201299	3
Comparative Performance	0.185177	4
Legibility	0.167823	5
Technical Efficiency & Usefulness	0.131669	6
Customer Expectation & Satisfaction	0.115468	7
Security	0.106012	8

It is obvious that the first rank goes to coherence (refers to the degree to which the environmental landscape hangs together, easy to understand & clear) and also complexity (richness of the elements in a setting) with the weight of 0.323025. The second rank is Responsiveness that means to be able to response to customer needs, with the weight of 0.212316.The third rank is reliability

with weight of 0.201299 that means ability to perform the promised service dependably and accurately and then comparative performance with the weight of 0.185177 that also means pay attention to performance of competitors, fifth rank goes to Legibility that means Distinctiveness, by possessing a memorable component, a landmark, and a scene facilitates finding one's way, with the weight 0.167823. In follows rank six belongs to technical efficiency & usefulness with the weight of 0.131669 that means do the right things and accordingly customer expectation & satisfaction that means whatever customers really want with the exact weight of 0.115468 and finally security (quality or state of being secured) with the weight of 0.106012.

Table 5.4 eight of most important parameters that affect on website quality ranked by their weight

Rank in TOPSIS	**Rank by AHP**	**Description**	**Area**
1	1	Coherence, Complexity	0.323025
2	2	Responsiveness	0.212316
4	3	Reliability	0.201299
5	4	Comparative Performance	0.185177
3	5	Legibility	0.167823
6	6	Technical Efficiency & Usefulness	0.131669
8	7	Customer Expectation & Satisfaction	0.115468
7	8	Security	0.106012

Table 5.2 shows the most important eight criteria that ranked at first with TOPSIS in the left column and the in the second time ranked by AHP based upon their weight that first rank is coherence, complexity with the weight 0.323025 and the second rank for responsiveness with approximately weight of 0.212316 and then reliability with the weight of 0.201299.

Then in follow, Comparative Performance as the forth rank by weight of 0.185177 and Legibility by weight of 0.167823 in the fifth rank and the sixth rank goes to Technical Efficiency & Usefulness with the weight of 0.131669 and the seventh is Customer Expectation & Satisfaction with the weight of 0.115468 and finally there is Security with approximately weight of 0.106012.

It would rather to shown all these parameters in different charts; below figure is a kind of pie chart that shown eight of most important parameters that are chosen between 22 parameters that affect on website quality so by mentioning thesis criteria, companies can have high improvement in website quality.

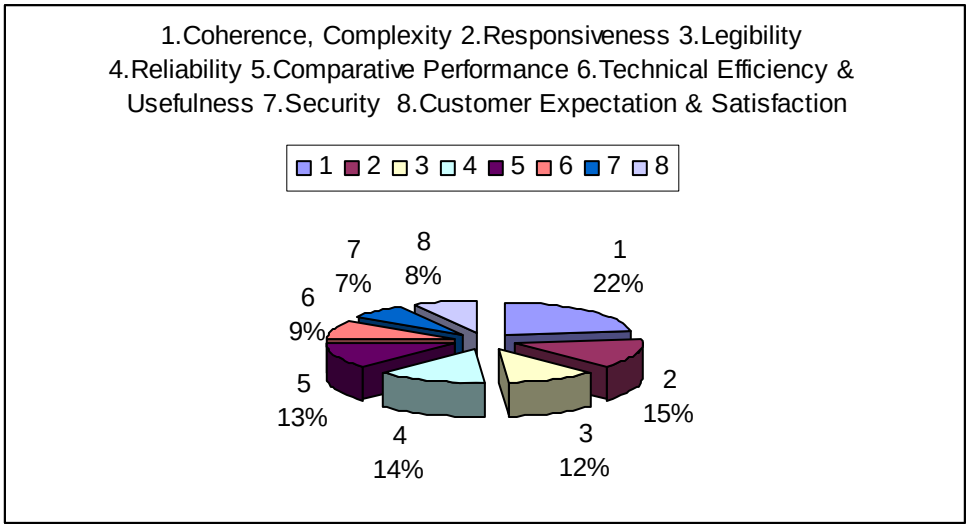


Fig.5.1 the pie chart of web quality parameters

Also in figure 5.2, it is obviously shown that the most important criteria among these eight is the coherence that refers to the degree to which the environmental landscape hangs together, easy to understand & clear and also complexity that refers to the richness of the elements in a setting with the approximately weight of 0.323025. These two both makes the shape of each website and in the analysis, it is understood that how much it may influences on web users.

Fig.5.2 the column chart of web quality parameters ranked by fuzzy TOPSIS

Figure 5.3 is a kind of pie chart that shows the weight of each parameter as a slice of a circle, as it is obvious the biggest slice is belong to the first ranked that is coherence that means the degree to which the environmental landscape hangs together, easy to understand & clear) and also complexity (richness of the elements in a setting) with the weight of 0.323025 that in the pie chart below has about 22 percent of the whole pie.

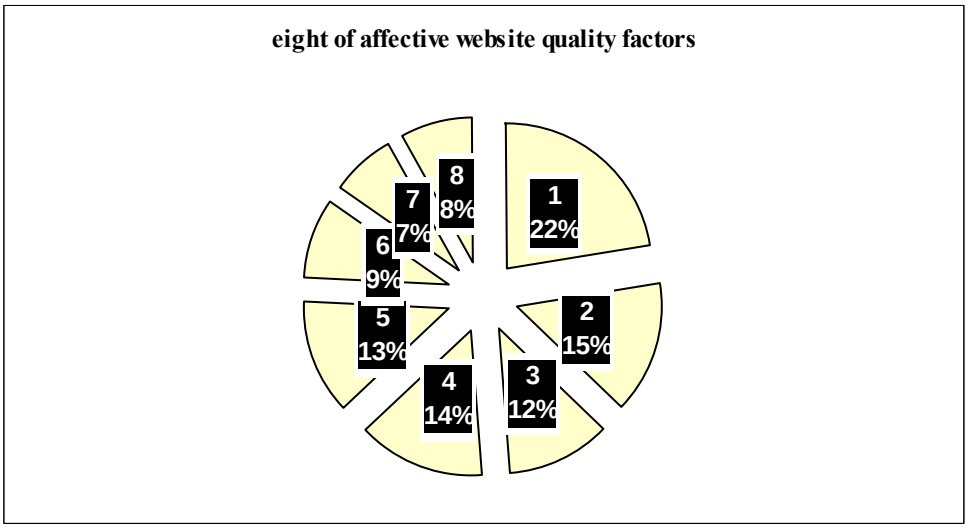


Fig.5.3 another kind of pie chart of web quality parameters

Number two is responsiveness that means to be able to response to customer needs, with the weight of 0.212316 with approximately 12 percent of whole pie. Number three is legibility that means distinctiveness, by possessing a memorable component, a landmark, and a scene facilitates finding one's way, with the weight 0.167823 and with approximately 14 percent of whole pie. In follows reliability with weight of 0.201299 and 14 percent of whole pie that means ability to perform the promised service dependably and accurately and then comparative performance with the weight of 0.185177 that also means pay attention to performance of competitors then six number belongs to technical efficiency & usefulness with the weight of 0.131669 that means do the right things and accordingly security (quality or state of being secure) with the weight of 0.106012 and finally customer expectation & satisfaction that means whatever customers really want with the exact weight of 0.115468.

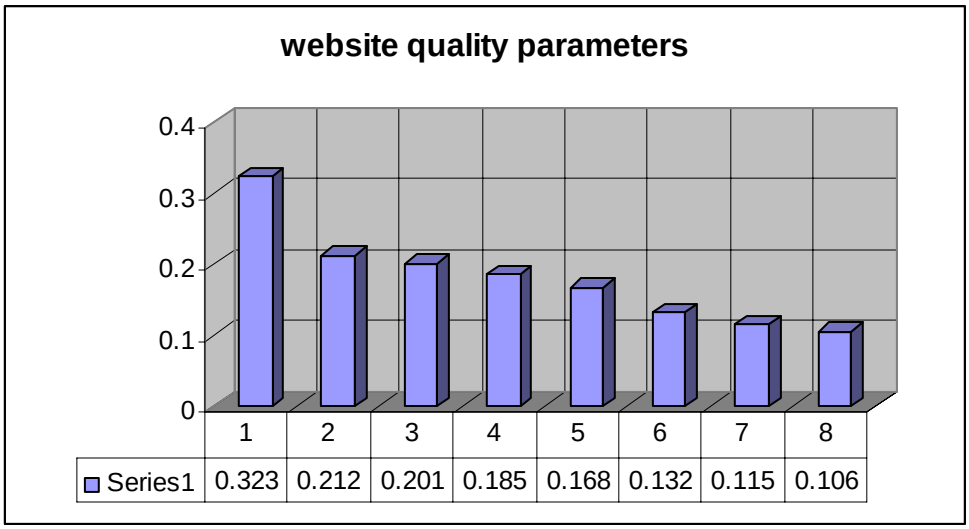


Fig.5.4 the column chart of web quality parameters ranked by fuzzy AHP

In fig 5.4 all the ranked parameters that rank with fuzzy AHP is shown with the column chart

The first rank is coherence, complexity by the weight of 0.323025, the second rank is responsiveness with the weight of 0.212316 and the third one is reliability with the 0.201299 in weights and forth rank goes directly to comparative performance with 0.185177 of weight and also fifth is legibility with weight about 0.167823. In number six there is a technical efficiency & usefulness with the approximate weight of 0.131669 and in follows customer expectation & satisfaction is in the seventh rank with the weight of 0.115468 and finally security with the weight of 0.106012 is in the eighth rank of the fuzzy AHP table.

The below table is the results of this thesis that contain a consequence of seventy people's idea (n=70) about website quality in e-book shops and also the component of it and it is also contain the preference about website quality parameters. As it is obvious the numbers 1 to 5 shows the preference (from not important =1 to very important =5) and also the left column shows the question number that there were about 22 questions in the questionnaire that each of them was a parameter of website quality.

Table 5.5 The result of questionnaire

	Not important	**Low important**	**Average**	**Important**	**Very important**
Question No. ↓	**1**	**2**	**3**	**4**	**5**
1	4	0	225	400	1089
2	0	25	784	900	49
3	0	100	900	400	100
4	144	196	100	196	361
5	16	36	676	484	121
6	0	9	225	784	576
7	9	49	1225	484	9
8	1	36	196	529	676
9	16	100	484	676	36
10	0	0	100	225	2025
11	1	16	144	169	1600
12	0	1	121	625	1089
13	0	9	289	961	361
14	1	16	784	484	169
15	4	1	9	144	2704
16	4	9	400	784	289
17	9	9	144	529	841
18	169	121	289	225	196
19	4	4	289	784	400
20	25	36	169	676	361
21	16	4	256	400	784
22	9	16	1089	529	36

First of all, the question number 1 that about 4 people answer it number 1 as not important at all and 225 people answered it as average and 400 people answered it as important and about 1089 answered it that it is very important. Therefore fig 5.5 shows the results of this question completely.

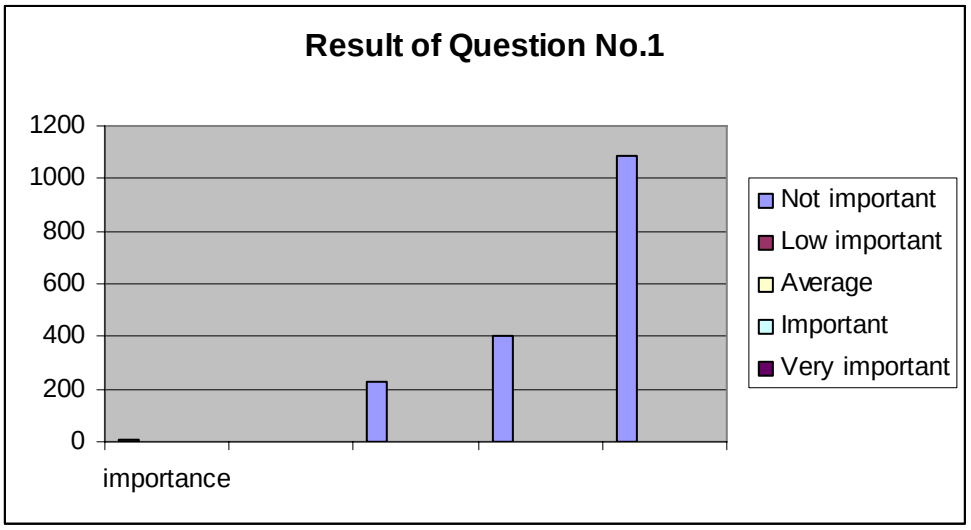


Fig.5.5 column chart of the result of question no.1

It is obviously, easy to understand that question no.1 is approximately very important to the people because about 87% of people chose it as important or very important and it is shown in fig 5.6.

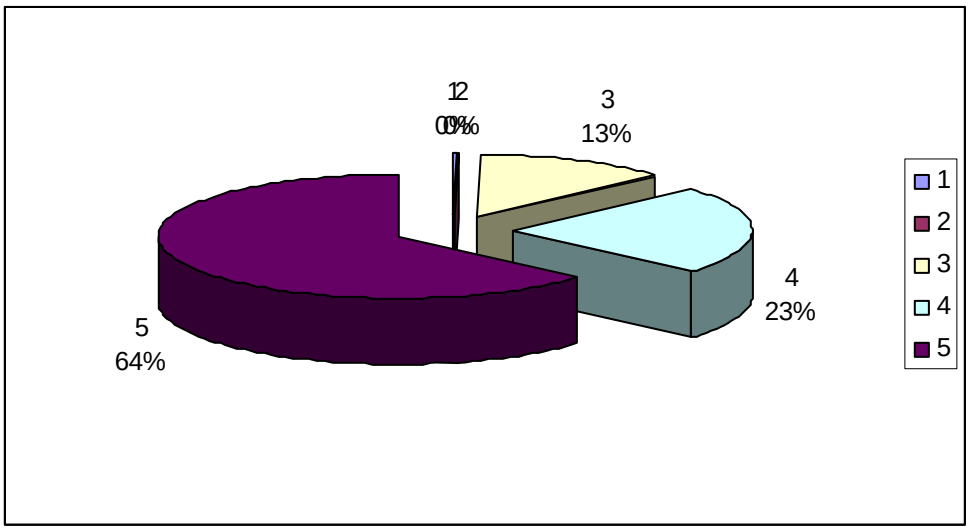


Fig.5.6 pie chart of the result of question no.1

About 64% of the sample society chose very important and about 23% chose important, 13% chose average and no one chose low important but 2% chose not important in preference of parameter no.1

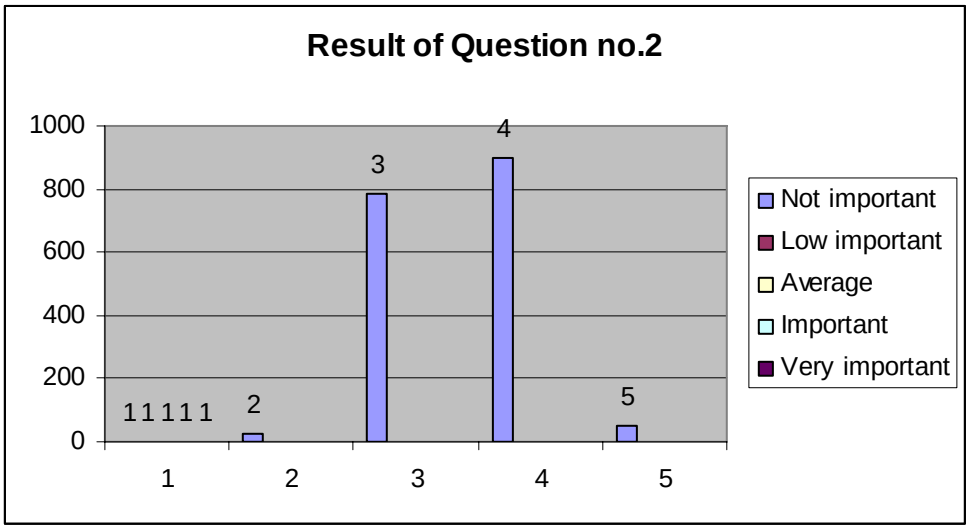


Fig.5.7 column chart of the result of question no.2

Fig 5.7 shows the result of question number 2 or the second parameter of website quality that was mentioned in the questionnaire. it is obvious that again lots of people answered it as average and important parameter in their preference of parameters.

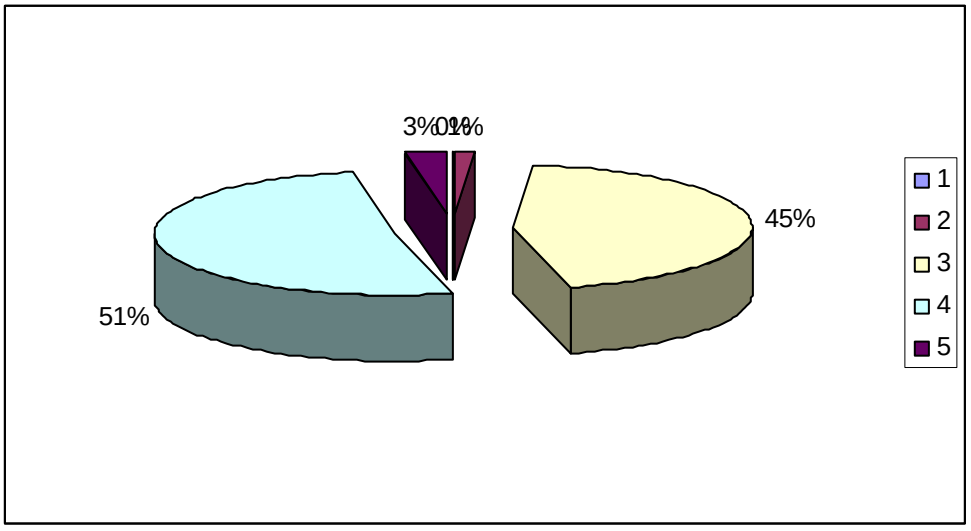


Fig.5.8 pie chart of the result of question no.2

In fig 5.8 the result of second parameter of questionnaire shown with pie chart and about 96% of people chose it as average and important in preference.

In question no.3, all the people mentioned it as an average in the preference but some chose it as important and the rate of people who chose it as very important and low important is the same.In fig 5.9 the column chart of the third question of the questionnaire was shown completely.

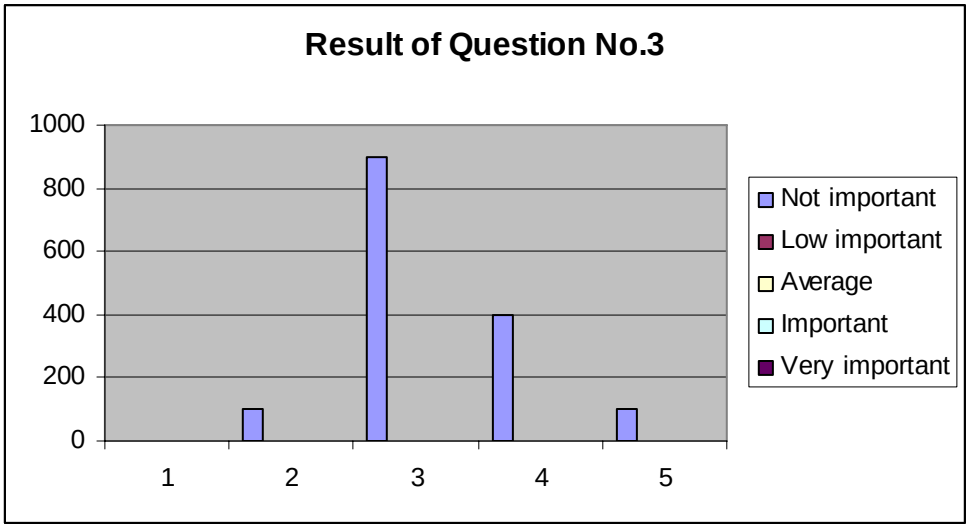


Fig.5.9 column chart of the result of question no.3

In fig 5.10 the result of question number three is shown as a pie chart and it is obvious that 59% chose it as average and 27% chose it as important in their preference of parameters in website quality.

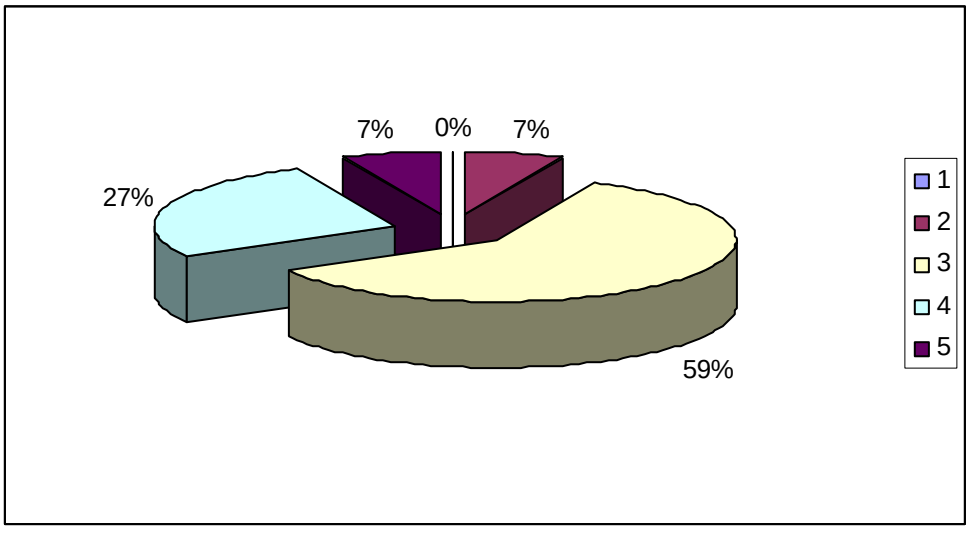


Fig.5.10 pie chart of the result of question no.3

In question number four, most of the people chose it as very important parameter and a few chose it as average and some people chose it as low important in their preference of website quality. In fig 5.11 that shows the column chart of the result of question no.4 it is understandable that this criteria is approximately important to people.

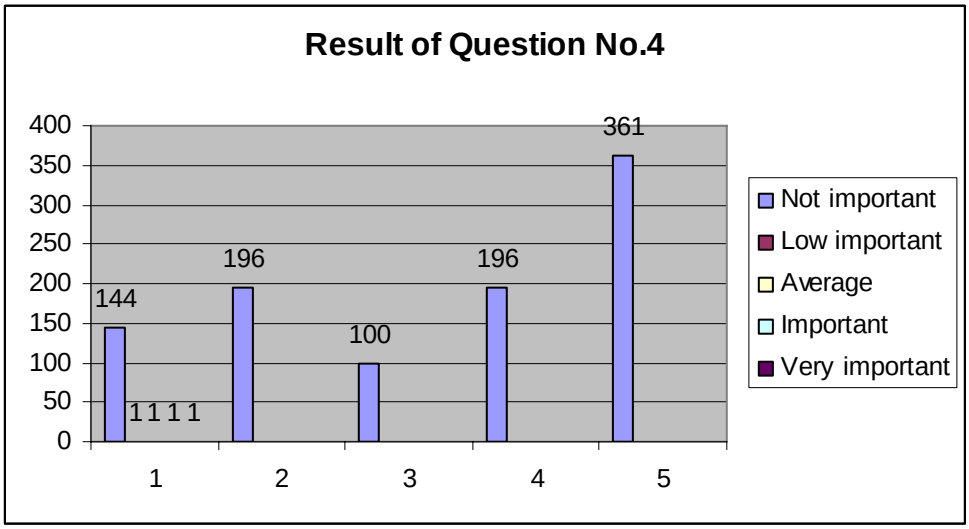


Fig.5.11 column chart of the result of question no.4

Fig 5.12 shows the pie chart for question number four and the percentage of each preference. The most important chosen part of this question is very important with 36 percent in preference.

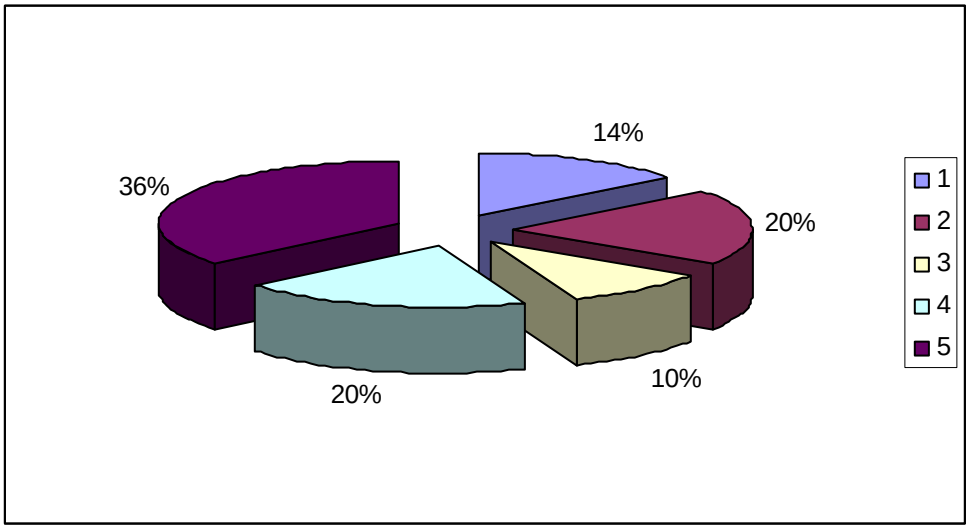


Fig.5.12 pie chart of the result of question no.4

Fig 5.13 shows the column chart of question number five that the most preference in this question was average and the second one was important and at last very important. Just few people answered it as not or low important.

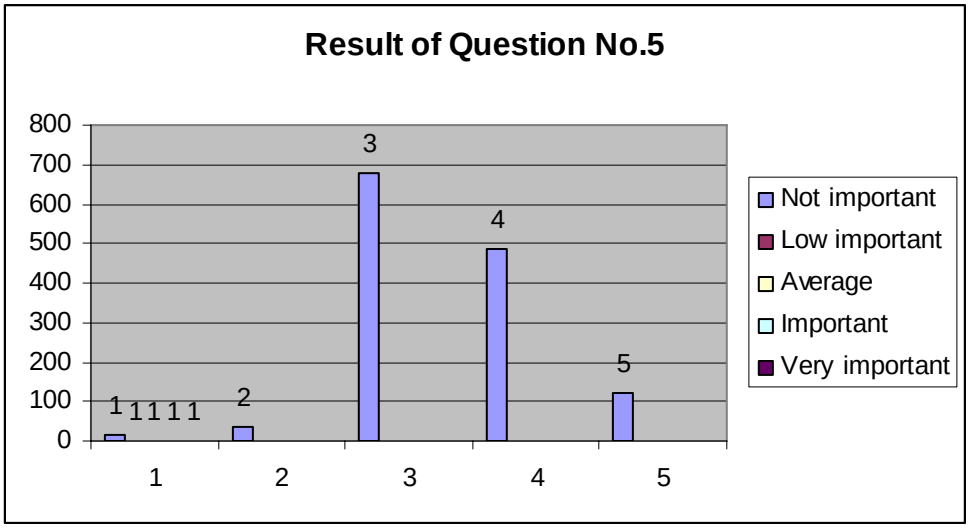


Fig.5.13 column chart of the result of question no.5

In fig 5.14 the result of question number five is shown like a pie chart with the percentage. The "average "with 51% and "important "with 36 percent in preference of website quality parameter.

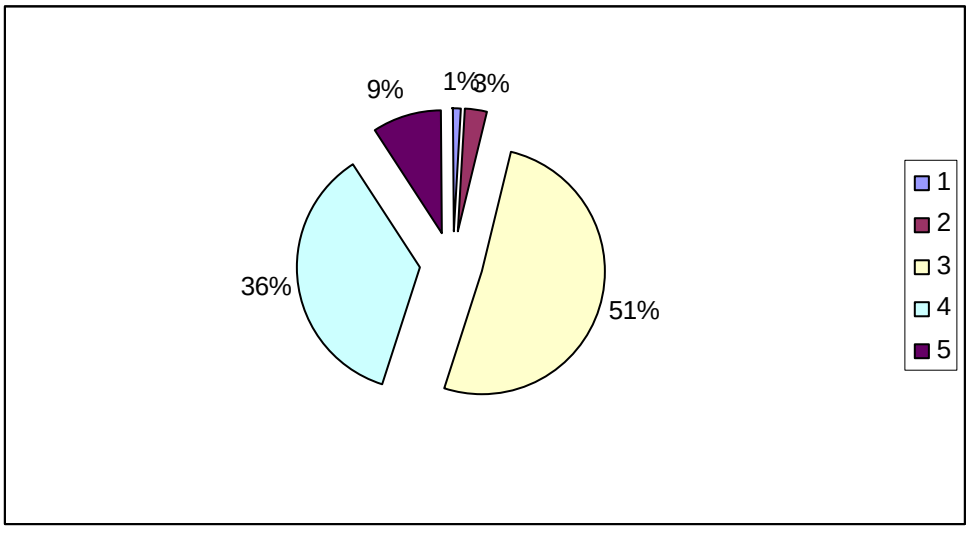


Fig.5.14 pie chart of the result of question no.5

Question number six, seems that was important to every one because lot of people chose it as important and also very important. Fig 5.15 shows the column chart of question number 6.

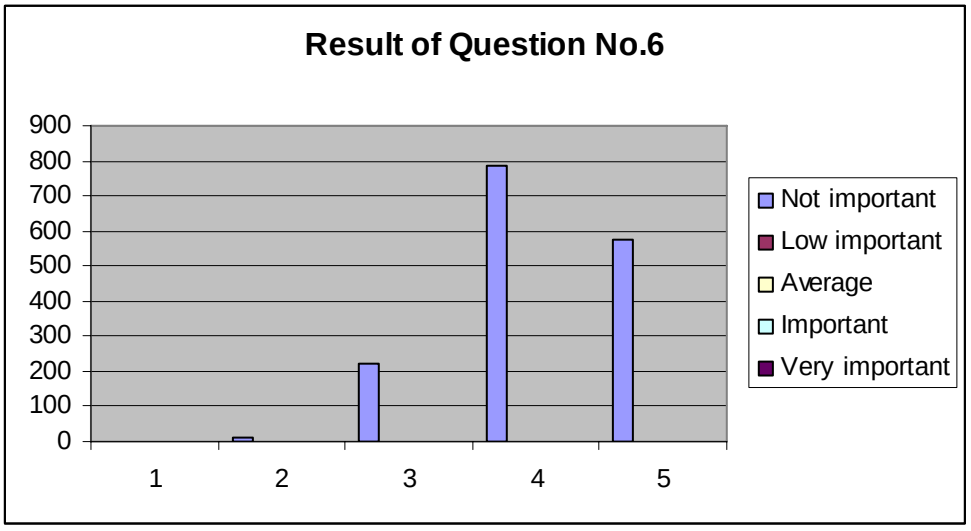


Fig.5.15 column chart of the result of question no.6

In fig 5.16 the pie chart of question number six with the percentage is shown and it is understandable that about 85percent of web user chose it as important and very important.

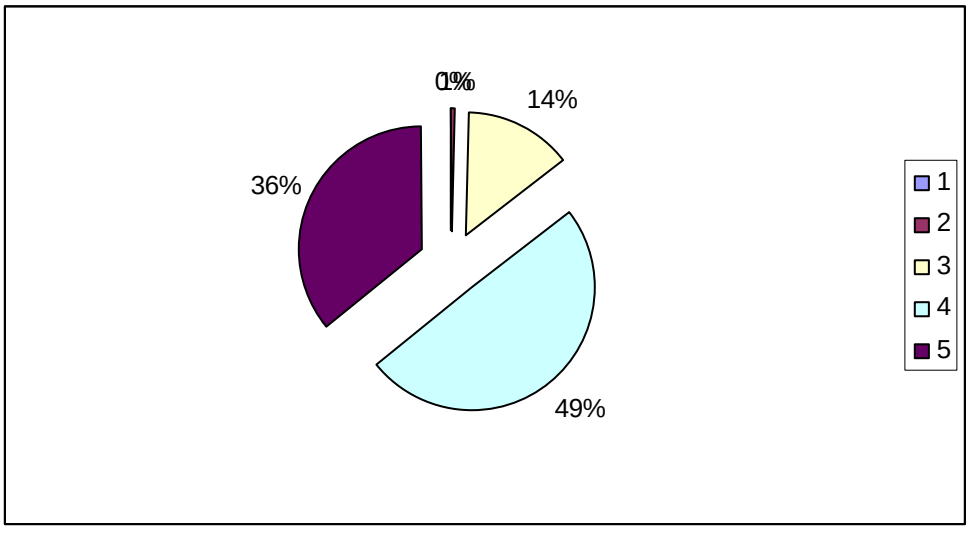


Fig.5.16 pie chart of the result of question no.6

In question number seven, approximately every one chose the average for this question but a few people chose the other preference. In fig 5.17 the column chart of the answer of question number seven is shown.

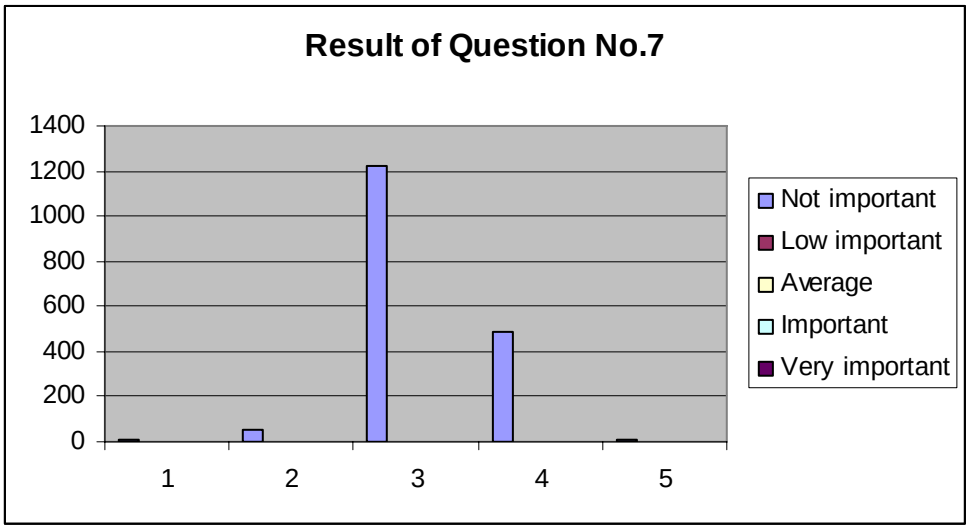


Fig.5.17 column chart of the result of question no.7

In fig 5.18 there is a pie chart of results of question number seven. About 68 percent chose it as an average in their preference. 27 percent chose it as important parameter of website quality in their mind.

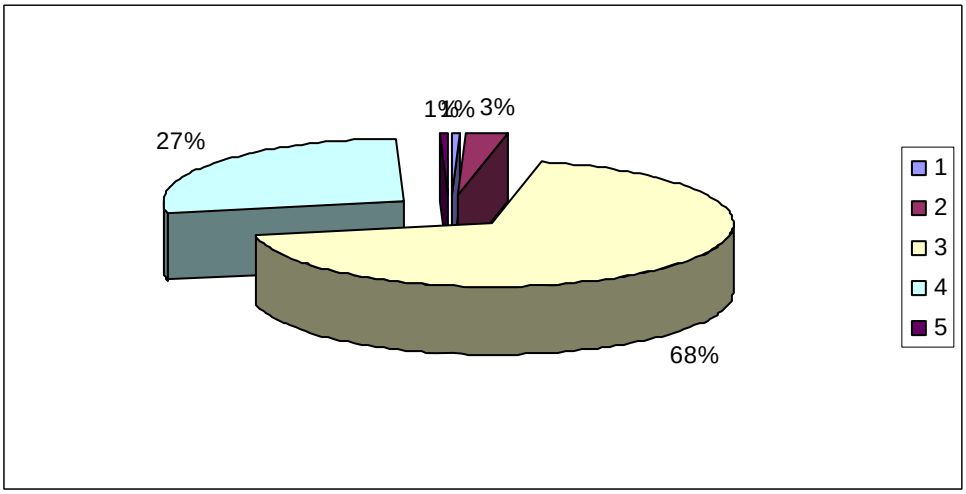


Fig.5.18 pie chart of the result of question no.7

Fig 5.19 shows the result of question number 8 that it is clear that the most preference of web users in this question is “important” and “very important”.

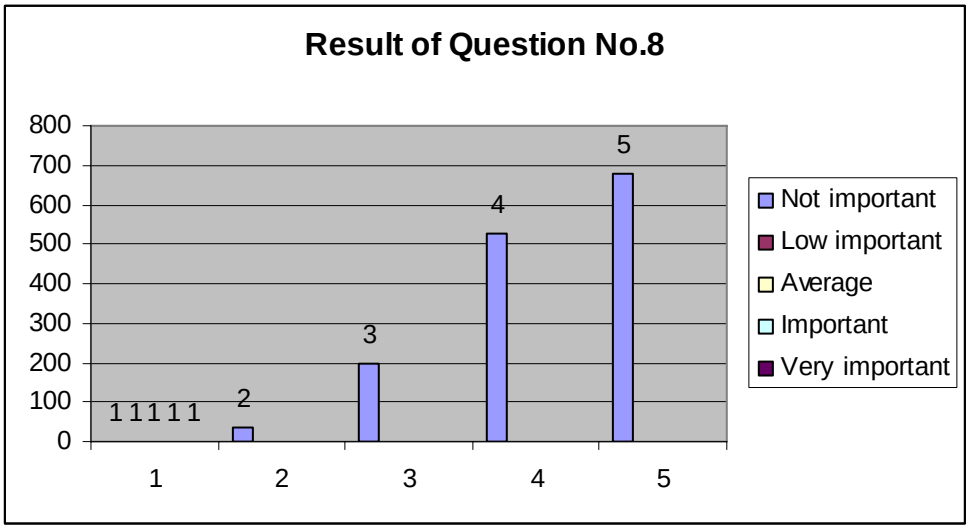


Fig.5.19 column chart of the result of question no.8

In fig 5.20 the pie chart of question number 8 is shown. In this chart about 86percent belongs to important and very important and share of average is about 14 percent and 3% goes directly to low important.

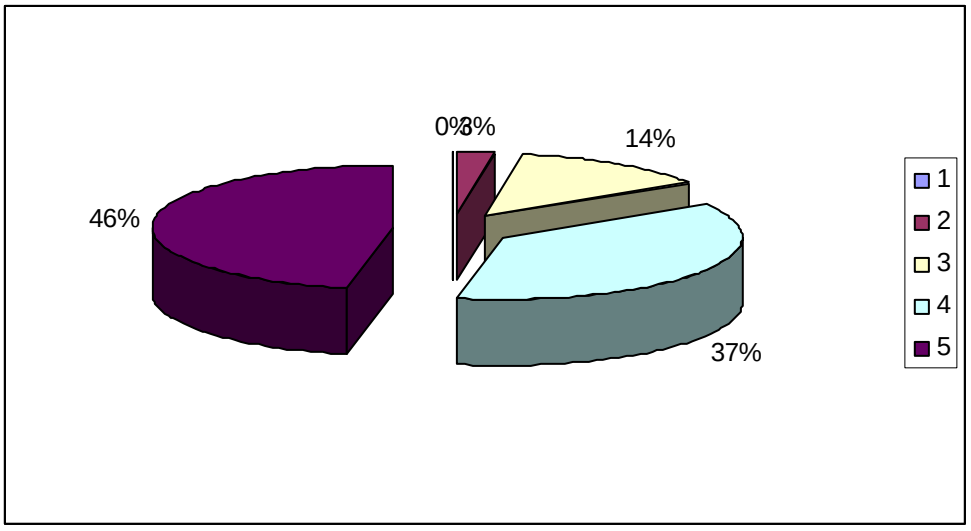


Fig.5.20 pie chart of the result of question no.8

In fig 5.21, the column chart of question number nine is shown that is lots of web user preferred important for this question and a lot of them also agreed with average for this parameter.

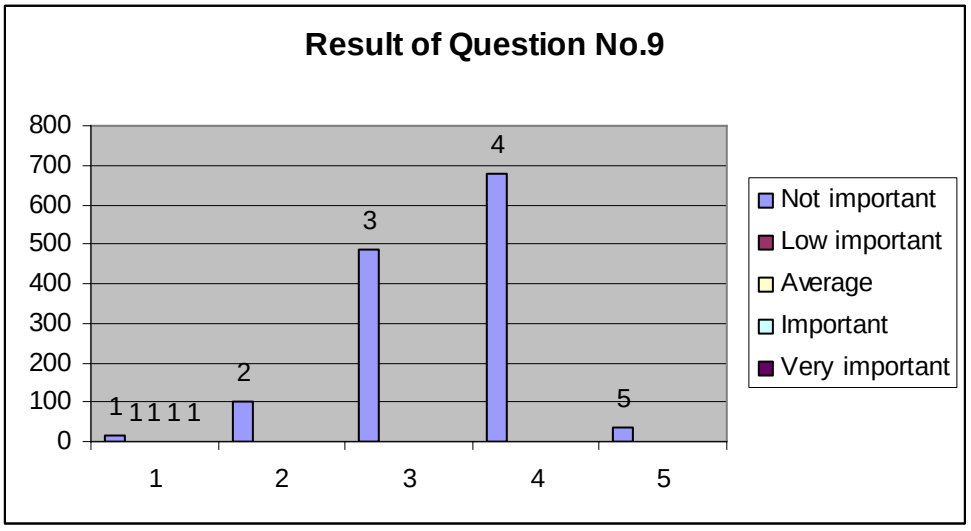


Fig.5.21 column chart of the result of question no.9

In pie chart of question number nine that is shown in fig 5.22, it is obvious that 51 percent of people chose important and also 37% chose average. About 3 percent chose very important and also 1% goes to not important and at the end 8% belongs to low important.

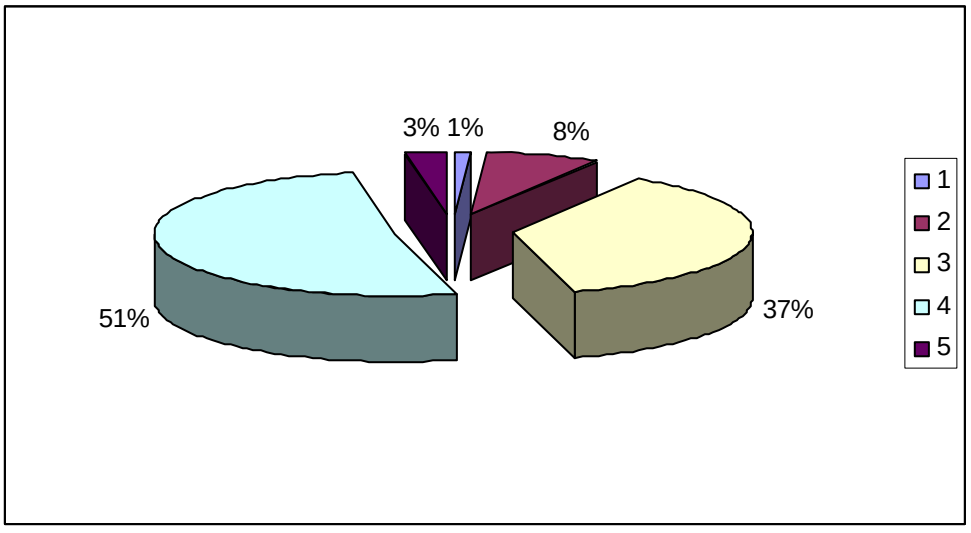


Fig.5.22 pie chart of the result of question no.9

In question number 10, as there is in the column chart in fig 5.23; “very important” is in the position that has a high difference with other preference, so it seems that this criteria is very important to web users.

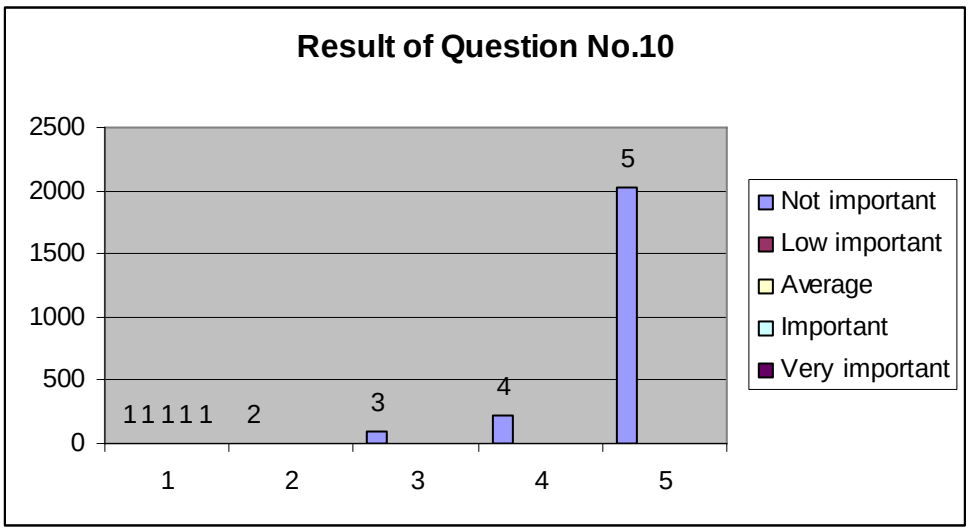


Fig.5.23 column chart of the result of question no.10

As it is clear that about 86 percent goes to “very important” and about 10% belongs to “important” and 4 percent for “average” and no one chose low or not important at all.

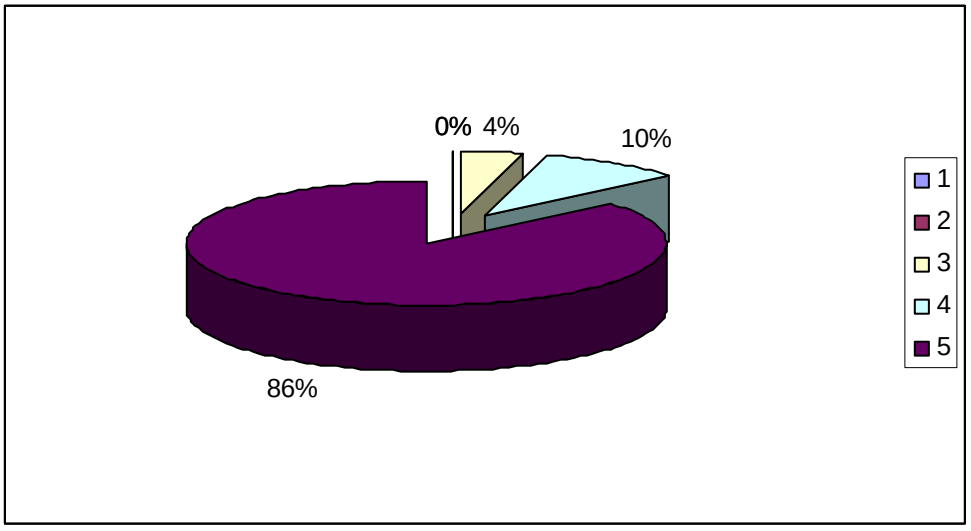


Fig.5.24 pie chart of the result of question no.10

In fig 5.25, the result of question number 11 is shown, as it is clear like question number 10, the "very important is in the higher position than the other preference.

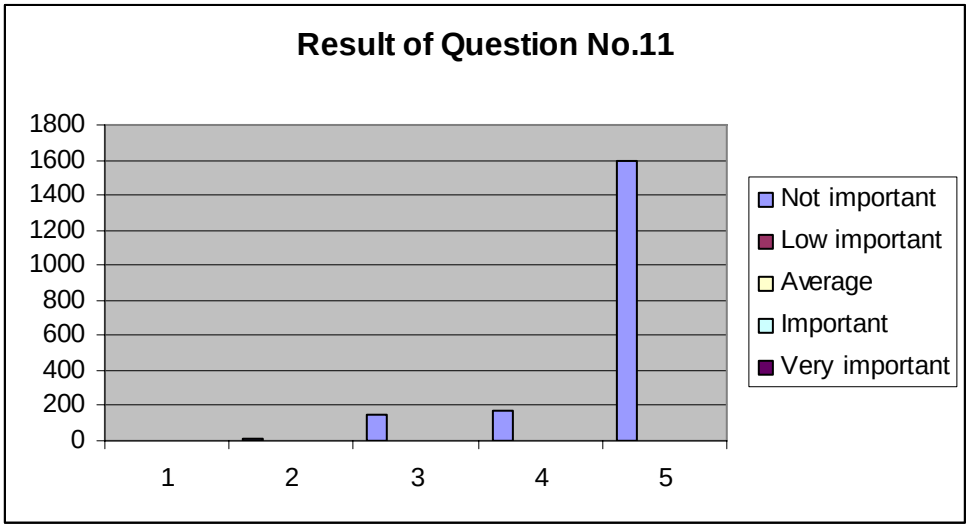


Fig.5.25 column chart of the result of question no.11

In fig 5.26 also the pie chart of question number eleven is shown, that about 83 percent is the "very important" and 9 percent goes to "important" also 7 percent belongs to "average" and 1 percent for "low important" and no one chose "not important" for this question

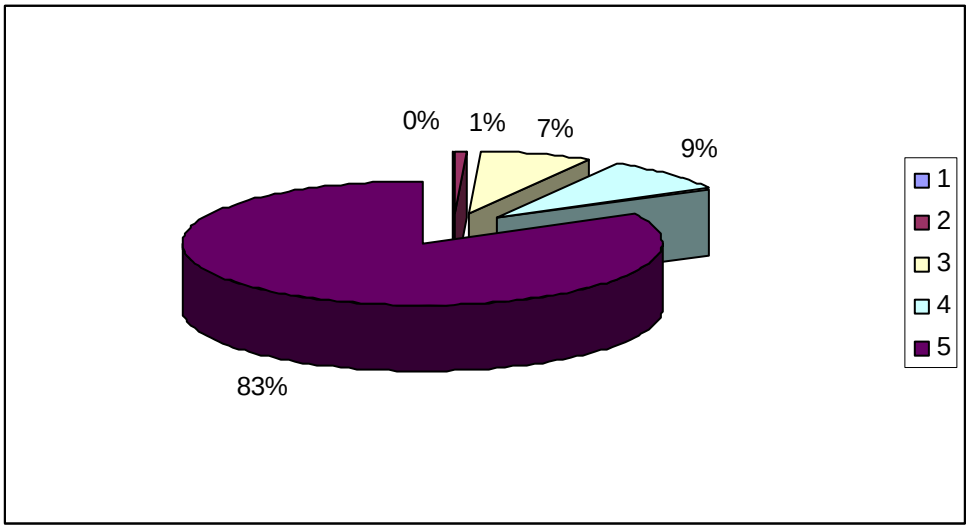


Fig.5.26 pie chart of the result of question no.11

For question number twelve; as there is shown in fig 5.27, both “important” and “very important” are in a higher position than the others. It means that most of web users preferred “important for this question.

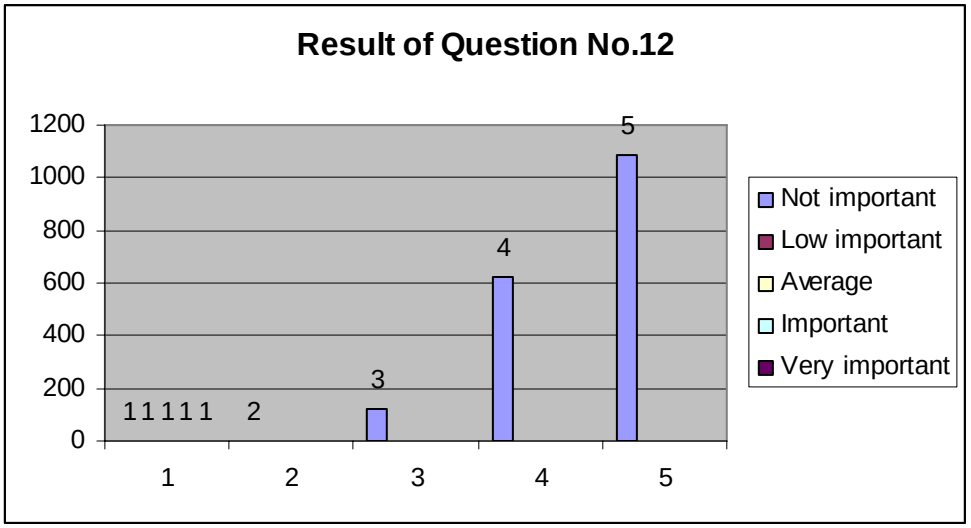


Fig.5.27 column chart of the result of question no.12

In fig 5.28, the pie chart of question number twelve is shown that; about 59 percent is belonged to “very important” and “34% goes directly to “important”, 7% for “average” and no one chose not or low important for this question.

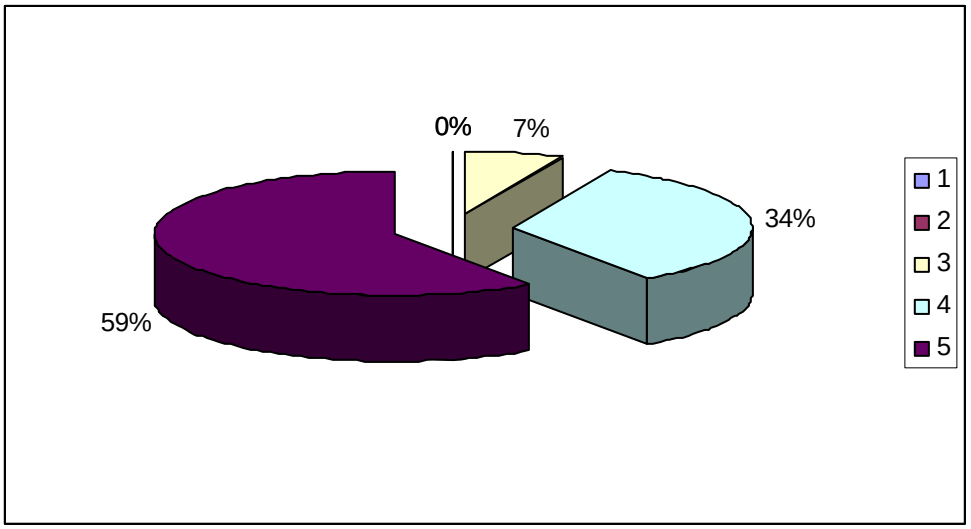


Fig.5.28 pie chart of the result of question no.12

Doing the analysis for question number 13; is to find out the column chart of the result of it that is shown in fig 5.29 as almost every web user chose “important” for this question.

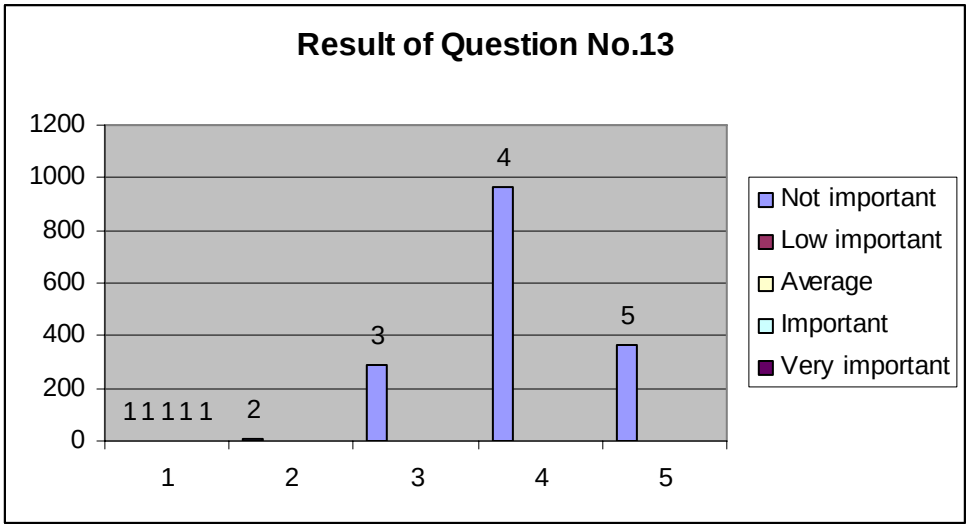


Fig.5.29 column chart of the result of question no.13

In continue, the pie chart of question number 13 is shown in fig.5.30 that is obvious that 59 percent belongs to “important” as the first choice and “very important” with the rate of 22% and “average” with 18 percent. 1% chose not or low important.

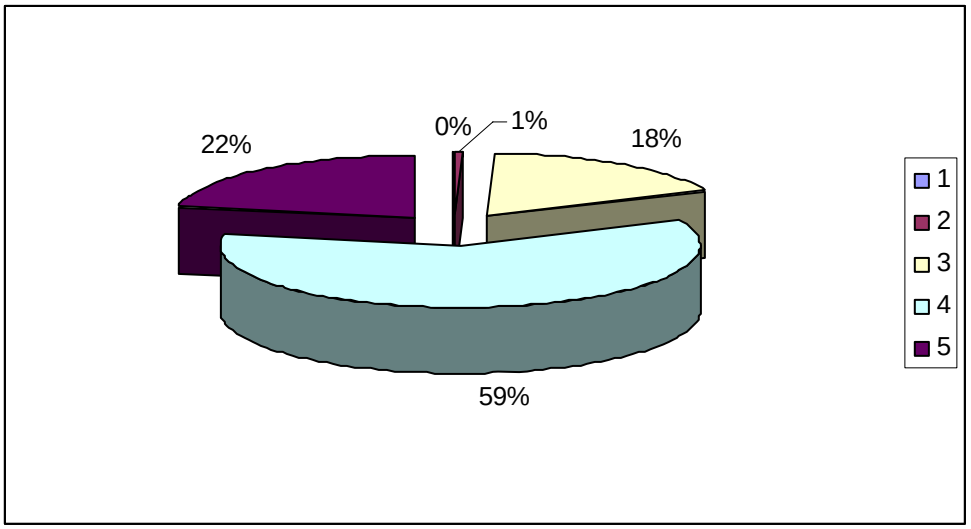


Fig.5.30 pie chart of the result of question no.13

There is a column chart for question number 14 that shows in fig 5.31 that it is clear that almost every web user chose “an average” for this question. In the follow “important” and “very important”.

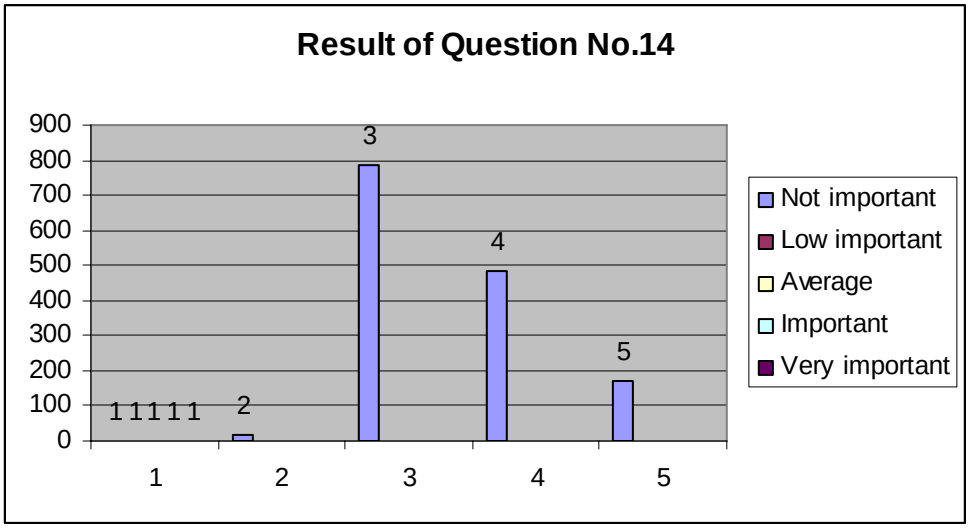


Fig.5.31 column chart of the result of question no.14

In pie chart of question number 14, about 54 percent goes to “average” preference and 33 percent for “important”, 12 percent for “very important” and a very few people chose not or low important for this question.

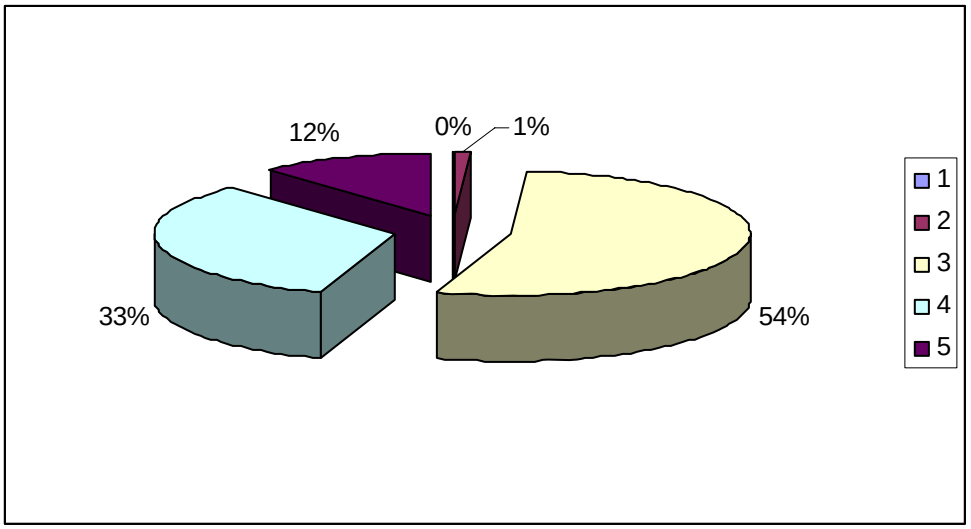


Fig.5.32 pie chart of the result of question no.14

In column chart of question number 15 that is shown in fig 5.33, the most important preference of people is “very important” and with a high gap there is “important” and no one chose the other preference for answering this question.

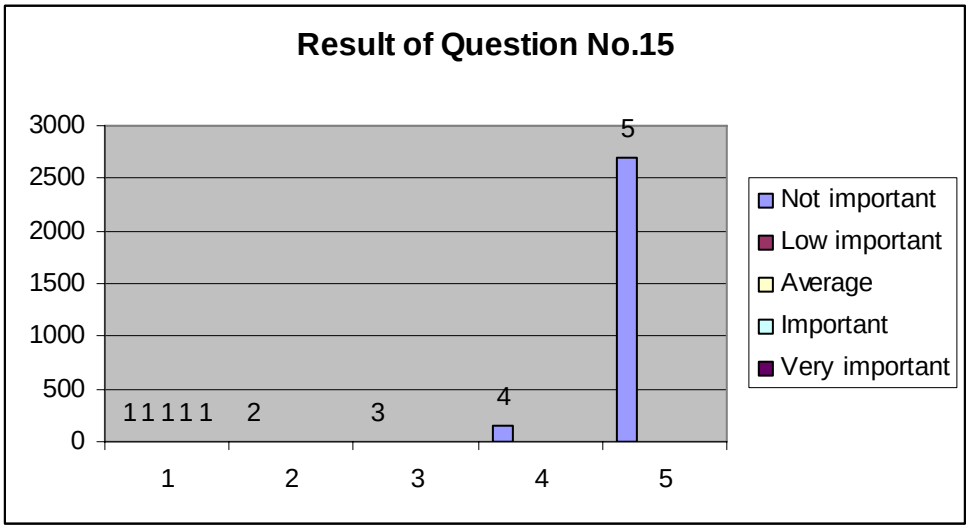


Fig.5.33 column chart of the result of question no.15

In question number 15 pie chart that is fig.5.34, it is obvious that 95 percent of web user chose “very important” in answering this question and just 5 percent chose ”important”.

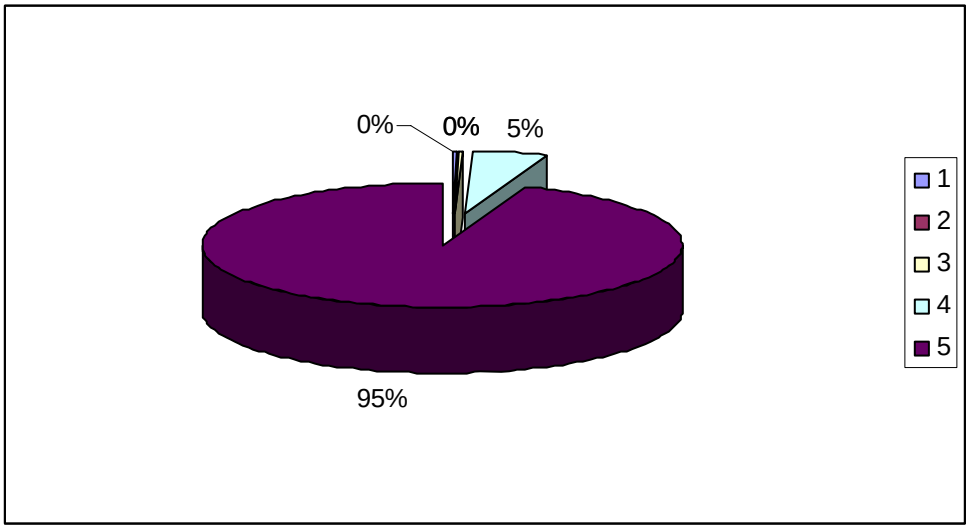


Fig.5.34 pie chart of the result of question no.15

In fig.5.35, the column chart of question number 16 is shown; “important” is number one in people preference, then “average” and the “very important” in follow.

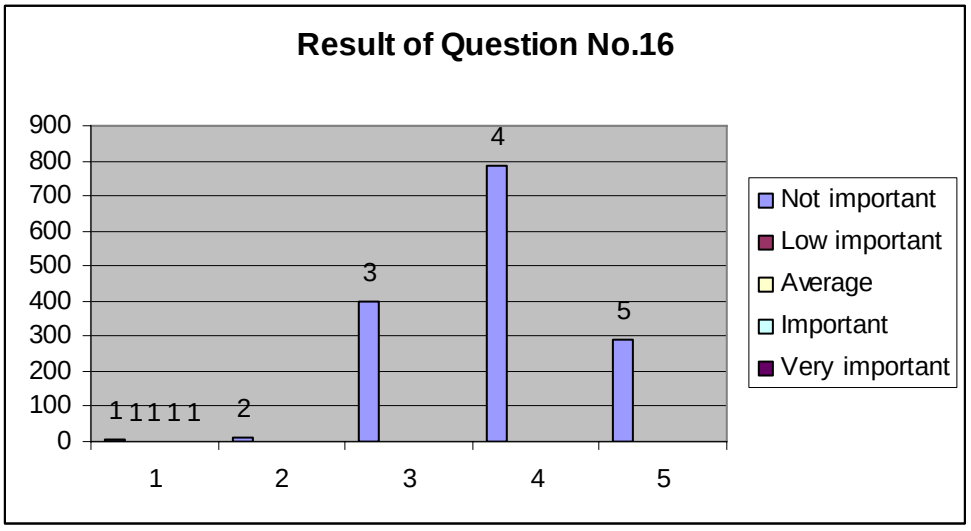


Fig.5.35 column chart of the result of question no.16

As it is clear in pie chart in fig.5.36 the “important” with 53 percent is the most preferred answer for this question and also “average” with 27 percent and “very important” with 19%in follow. No one chose “low” or “not” important at all.

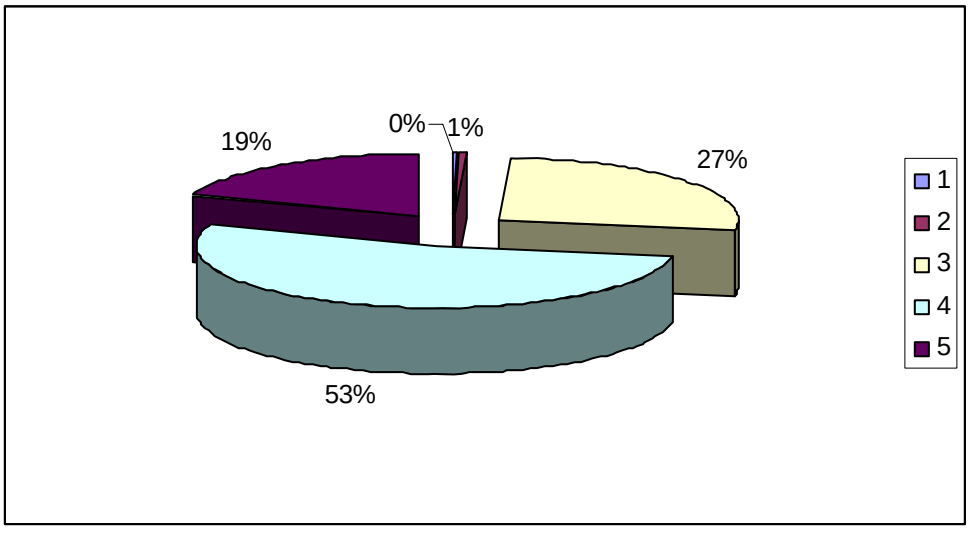


Fig.5.36 pie chart of the result of question no.16

In analyzing question number 17, there is a column chart in fig.5.37 that shows the very important in the first level of preferred answer for this question. Subsequently there are "important" and also "average".

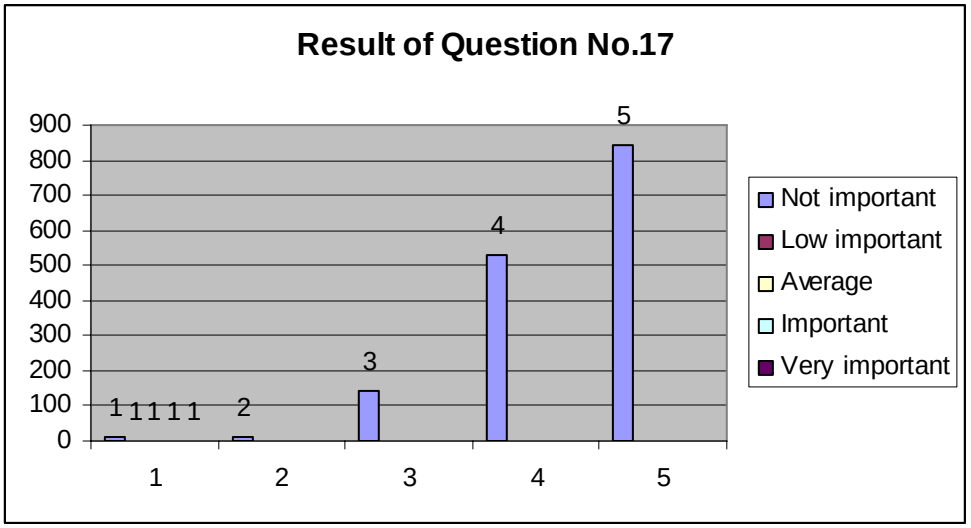


Fig.5.37 column chart of the result of question no.17

In pie chart of fig.5.38 is about question number 17 that shows about 54 percent of web user chose "very important" answer and 35 percent of people chose "important" and 9 percent chose an "average".

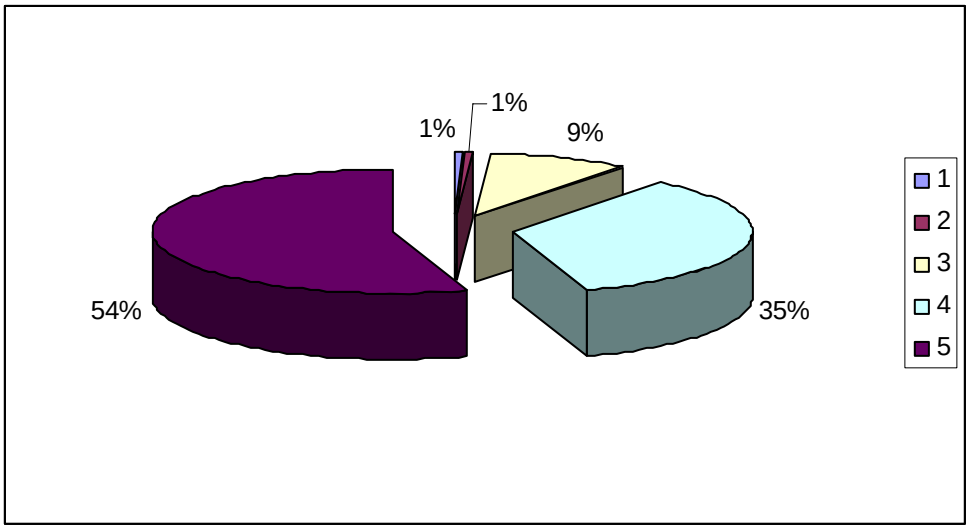


Fig.5.38 pie chart of the result of question no.17

In fig.5.39, the column chart of result of question number 18 is shown, in this question the idea were different, because approximately every preference are in the same measure. “average” is the most preferred answer of this question.

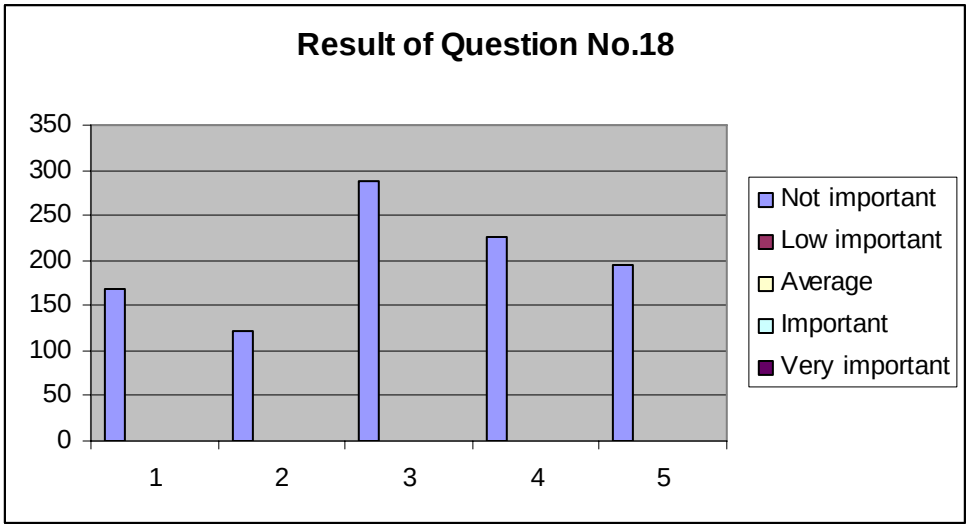


Fig.5.39 column chart of the result of question no.18

In fig5.40, there is a pie chart of question number 18 that shows 28 percent for the average answer and about 23 percent for “important” answer, 20percent for “very important” and 17 % for “not important” and 12 % for “ low important” answer.

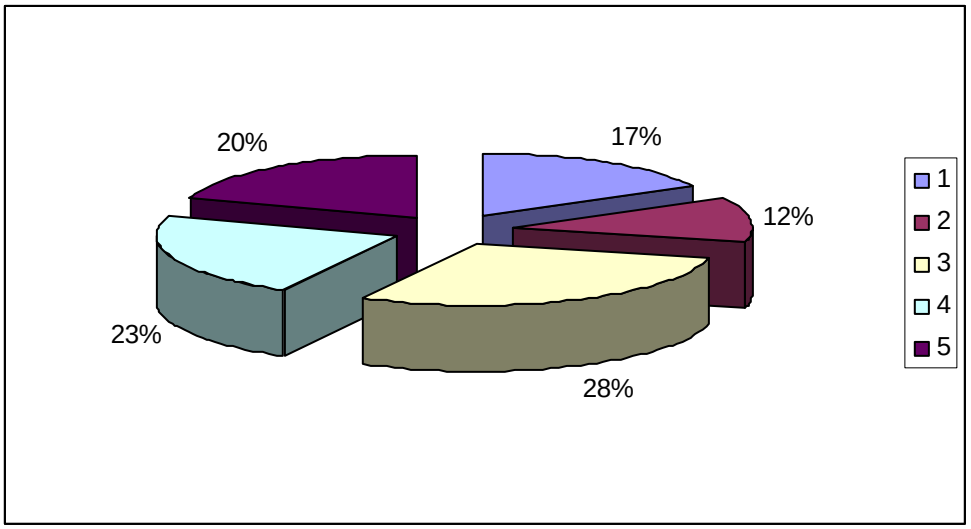


Fig.5.40 pie chart of the result of question no.18

In fig.5.41, the column chart of question number 19 is shown; “important” is number one in people preference, then “very important” and the “average in follow.

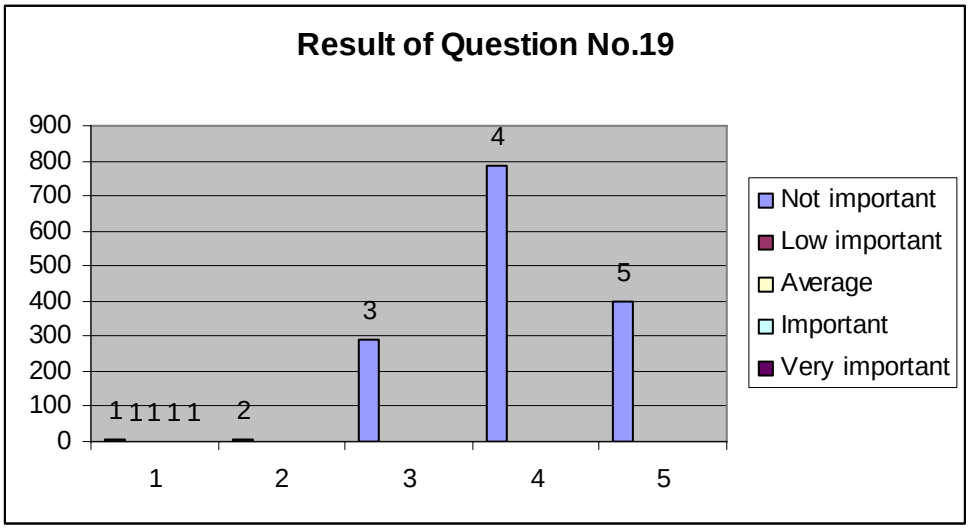


Fig.5.41 column chart of the result of question no.19

As it is clear in pie chart in fig.5.42 the “important” with 53 percent is the most preferred answer for this question and also “average” with 20 percent and “very important” with 27%in follow. No one chose “low” or “not” important at all.

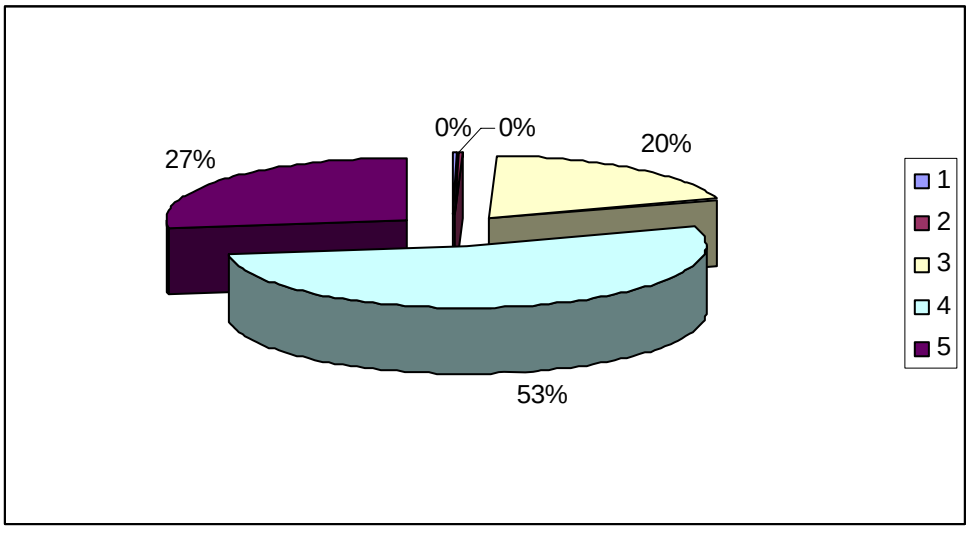


Fig.5.42 pie chart of the result of question no.19

In analyzing question number 20, there is a column chart in fig.5.43 that shows the “important” in the first level of preferred answer for this question. Subsequently there are “very important” and also “average”.

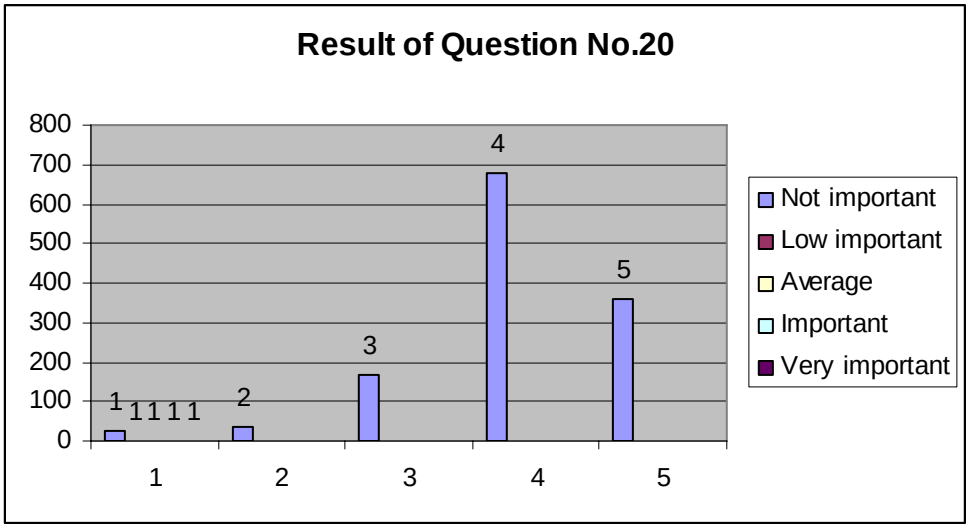


Fig.5.43 column chart of the result of question no.20

In pie chart of fig.5.44 is about question number 20 that shows about 54 percent of web user chose “important” answer and 28 percent chose “very important” and then 13 percent goes for “average” and 5 % for “low” or “not” important.

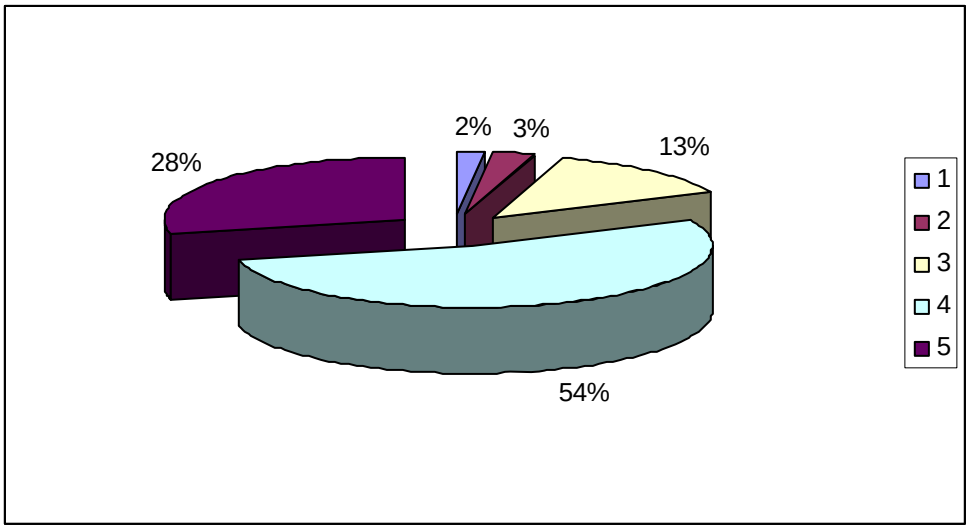


Fig.5.44 pie chart of the result of question no.20

In analyzing question number 20, there is a column chart in fig.5.45 that shows the very important in the first level of preferred answer for this question. Subsequently there are "important" and also "average", no one chose "low" or "not" important for this question.

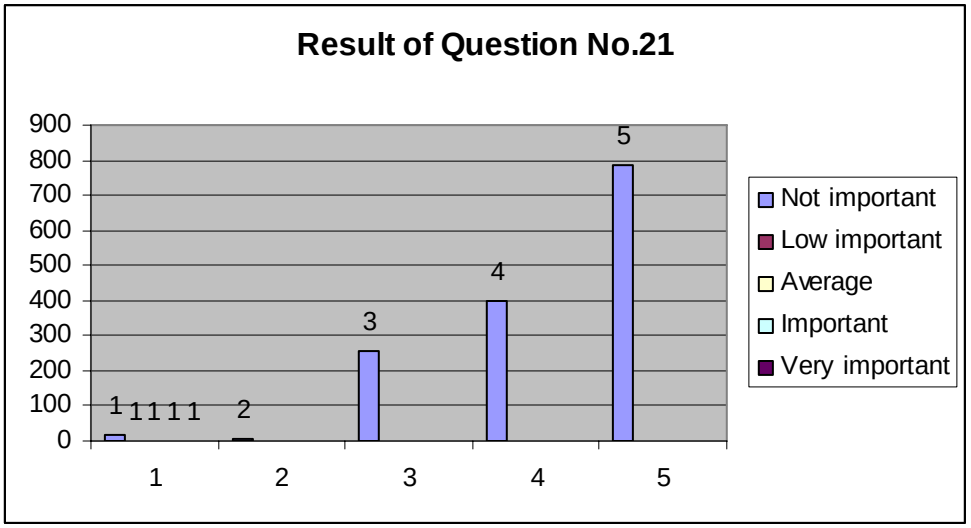


Fig.5.45 column chart of the result of question no.21

In pie chart of fig.5.46 is about question number 20 that shows about 54 percent of web user chose "very important" answer and 27 percent of people chose "important" and 18 percent chose an "average". Just a few people answered to "low" or "not" important.

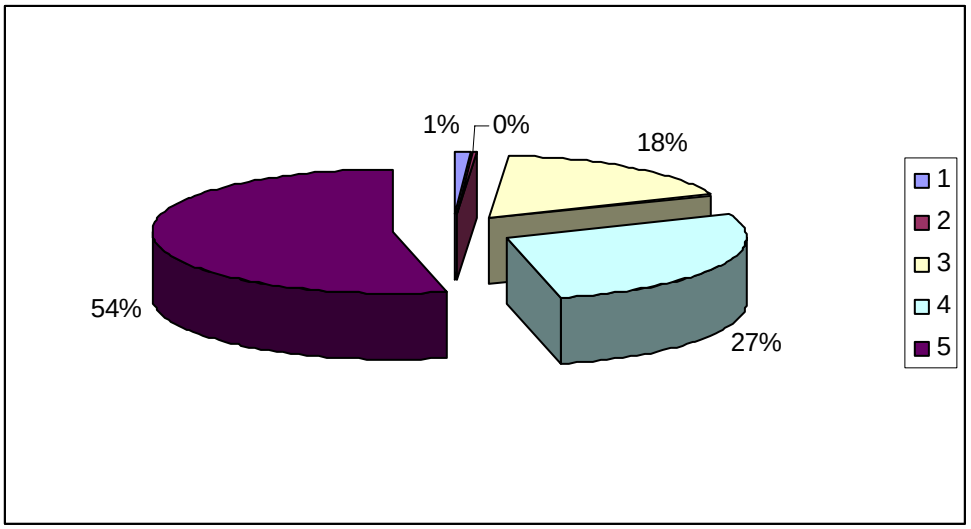


Fig.5.46 pie chart of the result of question no.21

In column chart of question number 22 that is shown in fig 5.47, the most important preference of people is “average” and with a high gap there is “important” and no one chose the other preference for answering this question.

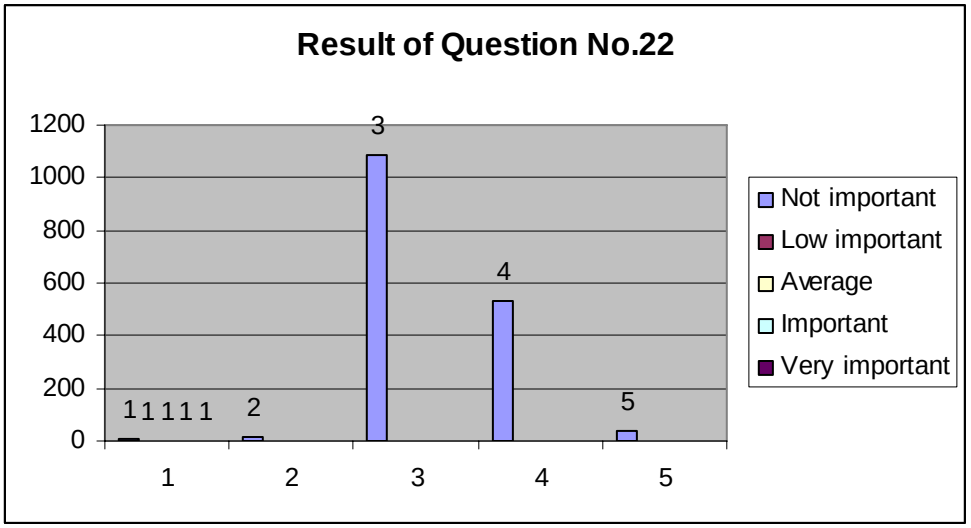


Fig.5.47 column chart of the result of question no.22

In question number 22 pie chart that is fig.5.48, it is obvious that 64 percent of web user chose “average” in answering this question and 32 percent chose ”important” and a few web user answered to this question as “not” or “low” or “very” important.

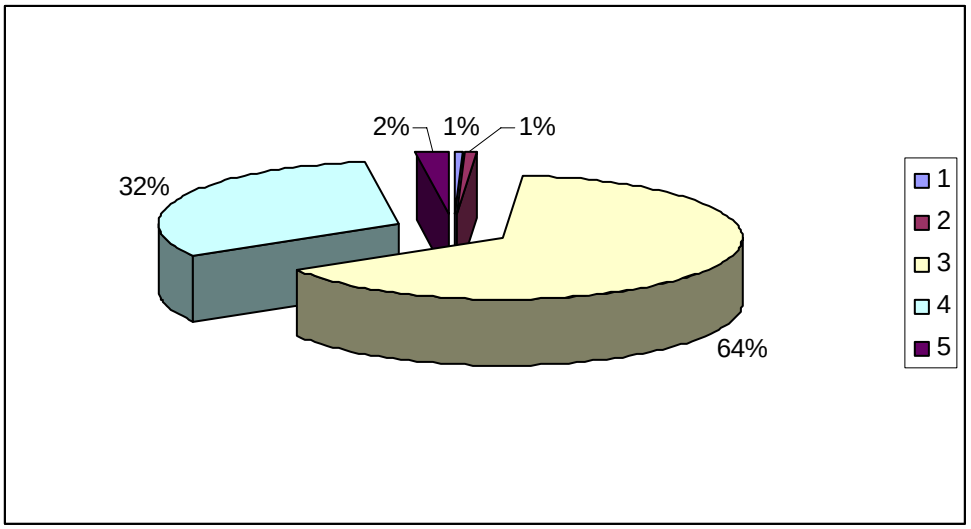


Fig.5.48 pie chart of the result of question no.22

Limitation of Thesis

Using a method to clarify parameters that affect on website quality with fuzzy approach with a case study in Iran is not an easy process. The first reason is that because a lot of people don't buy through the website even those who buy books through the web were a few.

The first part of difficulty is about finding people who buy their books through the internet in order to fill the first questionnaire that was about Iranian e-bookshop website quality. Because buying through the internet is somehow a new process in countries likes Iran.

The second difficulty is about working with fuzzy concept that was really difficult especially with people who doesn't know it at all. The fuzzy concept and also fuzzy trapezoid number is not familiar with people and because of the second questionnaire of fuzzy AHP the writer had to explain all of the details to those who supposed to full fill the questionnaire carefully and it took a lot of time to make a pairwise matrix of fuzzy AHP.

Suggestion for Further Research

In this research all of the parameters that affect on website quality were clarified completely. The case study was electronic bookshop in Iran. Comparing the parameters using fuzzy set theory and fuzzy numbers (fuzzy trapezoid numbers) also normal numbers made this opportunity to rank and weight all the affective parameters.

It could be possible for further research to compare affected parameters on website quality both in Iran with the advanced countries that buying thought the web is somehow the easiest way of buying, to find how to increase the quality of commercial website in Iran. Also it is possible to compare two of most important e-bookshop websites in Iran in order to comprehend which factors may cause success or which factors may encourage people to buy through the internet.

The last suggestion for further research is to measure the parameters of website quality of Iranian e-bookshop websites in order to increase them and in follow to get progress in sale as successful websites like amazon.com. But at first amazon.com should analyze very carefully in a way that critical factors that cause a website to be successful in worldwide clarified precisely.

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Appendix

4.1. Questionnaire

According to the affective factors on website quality, it is requested to fill this table and specify the importance of each factor as below:

1= not important 2=low important 3=average 4=important 5=very important

No.	Parameters	1	2	3	4	5
1	Coherence (Refers to the degree to which the environmental landscape hangs together, easy to understand & clear)					
2	Complexity (Richness of the elements in a setting)					
3	Legibility (Distinctiveness, by possessing a memorable component, a landmark, a scene facilitates finding one's way)					
4	Mystery (Enhances one's desire to explore a space by conveying the feeling that much more can be found if one keeps on going)					
5	Relevance (Relevant depth and scope, and completeness of the information)					
6	Usefulness (Website has lots of benefits for users)					
7	Specialization (Adjusted Related information)					
8	Website navigation (Website's capability to provide alternative interaction and navigating techniques)					
9	Personalization (Making personal files for customers)					
10	Currency (The state of being in common or general use)					
11	Security (Quality or state of being secure)					
12	Classification of needs (Basic , performance or excitement needs)					
13	Technical efficiency (Do the right things)					
14	Web design (Architecture of the website)					
15	Reliability (Ability to perform the promised service dependably and accurately)					
16	Responsiveness (To be able to response to customer needs)					
17	Trust (Customer should have confidence to the website)					

No.	Parameters	1	2	3	4	5
18	Customer expectations and Satisfaction (What customers really want)					
19	Awareness (Existence of a critical mass who knows and experiences the website)					
20	Reputation (Overall quality as seen or judged by online consumers)					
21	Price saving (Lower the cost of online purchasing)					
22	Comparative Performance (Pay attention to performance of competitors)					
23	In your opinion, is there any import factor which affect on website quality? Please write them. 1. 2. 3.					